Hallstatt Textiles

Technical Analysis, Scientific Investigation and Experiment on Iron Age Textiles

Edited by

Peter Bichler
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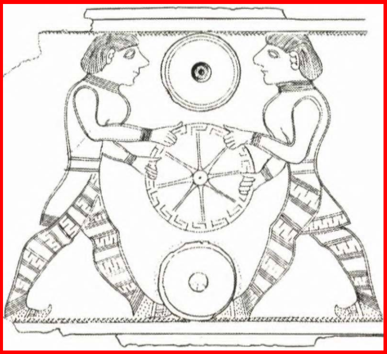

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Hallstatt Textiles

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COVER IMAGE *Detail from a scabbard from the Hallstatt cemetery, Early Iron Age (Drawing: M. Kliesch, RGZM, © Naturhistorisches Museum Wien, Prähistorische Abteilung)*

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Foreword of the Austrian Commission for UNESCO
Grußworte der Österreichischen UNESCO-Kommission

The region Hallstatt-Dachstein/Salzkammergut was inscribed on the UNESCO World Heritage List in 1997. The decision was taken in appreciation of the more than 2.500 years of history of this Austrian cultural heritage with its major archaeological and spelaeological sites, but also with due regard to the picturesque appearance of the region characterised by its variable alpine landscapes and their rare fauna and flora. By its admission of the region to its List, UNESCO recognised the salient importance and uniqueness of the Hallstatt culture and its artefacts for all of humanity.

By its Convention concerning the Protection of the World Cultural and Natural Heritage (1972) and the Convention for the Safeguarding of the Intangible Cultural Heritage, passed in 2003, UNESCO wishes to draw the world's attention to the cultural treasures of humankind and to call for their preservation.

A part of this cultural heritage that is to be preserved for posterity is the important textile finds from the Hallstatt culture. Even though less spectacular and less well-known than the pyramids of Gizeh or the Chinese Wall, they are nevertheless of an artisanry and skilfulness that make them key witnesses of everyday life 3.000 years ago and thus equal to the monumental buildings included in the World Heritage List.

The Austrian UNESCO Commission is therefore pleased to sponsor the conference of "Hallstatt Textiles" organised by the Austrian Society for Textile-Art-Research, the Vienna Museum of Natural History and the University of Applied Arts Vienna, Department of Archaeometry, and wishes the meeting much success and interesting finds.

Die Region Hallstatt-Dachstein/Salzkammergut wurde 1997 in die Liste des UNESCO Weltkultur- und -naturerbes aufgenommen. Ausschlaggebend dafür war die über 2.500 Jahre bestehende Kulturlandschaft mit bedeutenden archäologischen und speläologischen Fundstätten, aber auch das pittoreske Landschaftsbild der Region, das von abwechslungsreichen alpinen Landschaftsformen mit seltener Fauna und Flora geprägt ist. Mit der Eintragung anerkennt die UNESCO die herausragende Bedeutung und Einzigartigkeit der Zeugnisse der Hallstattkultur für die gesamte Menschheit.

Mit der verabschiedeten Internationalen Konvention zum Schutz des Kultur- und Naturerbes von 1972 wie auch mit der 2003 verabschiedeten Konvention zum Schutz des Immateriellen Kulturerbes möchte die UNESCO weltweit die Aufmerksamkeit auf die kulturellen Schätze der Menschheit lenken und für deren Bewahrung eintreten.

Teil dieses kulturellen Erbes, das für die Nachwelt überliefert werden soll, stellen auch die bedeutenden Textilfunde der Hallstattkultur dar. Auch wenn sie nicht so spektakulär und bekannt wie die Pyramiden von Giseh oder die Chinesische Mauer sind, sind sie aufgrund der hohen Kunstfertigkeit als bedeutende Zeugnisse der Alltagskultur vor 3.000 Jahren den Monumentalbauten auf der Welterbe-Liste an Wert gleichzusetzen.

Die Österreichische UNESCO-Kommission hat daher gerne die Schirmherrschaft über die Tagung „Hallstatt-Textilien" – veranstaltet von der Gesellschaft zur Förderung der Textil-Kunst-Forschung, dem Naturhistorischen Museum Wien und der Universität für Angewandte Kunst Wien, Abteilung Archäometrie – übernommen und wünscht der Tagung viel Erfolg und interessante Ergebnisse.

Gabriele Eschig
Generalsekretärin
Secretary-General

Acknowledgements
Danksagung

This volume grew out of the papers, posters and discussions at the conference on „Hallstatt Textiles" held from 4th to 6th June 2004 at Hallstatt/Austria.
Der vorliegenden Band entstand aus den Vorträgen, Posterpräsentationen und Ergebnissen des Symposiums „Hallstatt-Textilien", das vom 4.-6. Juni 2004 in Hallstatt/Österreich stattfand.

The publication of the conference-proceedings was partly financed by the Austrian UNESCO Commission.
Here I would also like to thank John Peter Wild for correcting the English papers and David Davison & Gerry Brisch from British Archaeological Reports for all their help.
Die Publikation des Tagungsbandes wurde mit Mitteln der Österreichischen UNESCO-Kommission gefördert. Für die Publikation gilt unser besonderer Dank John Peter Wild, der die Korrektur der englischen Texte übernommen hat, sowie David Davison & Gerry Brisch von British Archaeological Reports für die Hilfe bei der Drucklegung.

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University of Applied Arts Vienna, Department of Archaeometry
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Preface of the Editors
Vorwort der Herausgeber

The aim of this publication is to provide an overview of the first Symposium on the Hallstatt textiles which was held in June 2004 in the picturesque village of Hallstatt, Upper Austria. The theoretical framework for this publication is derived from the various papers, poster sessions and exhibitions which contributed to a fuller understanding of the rich Hallstatt textile heritage.

The region of Hallstatt was inscribed on the UNESCO World Heritage List in 1997. Hallstatt's cultural heritage is based on over 7.000 years of continuous salt-mining. Extensive trade in the 'white gold', enabled this small community to develop into a metropolis during the 'Hallstatt Period'. Although there would appear to be no remains visible on the surface of the dwelling in the high valley, deeper penetration of the pre-historic mines, reveals a true treasure trove of artefacts such as miners tools, bowls, remains of food and most importantly textiles of a sophisticated structure. These artefacts provide a key witness to the everyday life of the miners of Hallstatt 3.000 years ago.

The Austrian Society for Textile Art Research (TKF) in co-operation with the Natural History Museum, Vienna and the University of Applied Art, Vienna, initiated and co-ordinated this symposium with the aim of bringing Hallstattt textiles to an international platform. This symposium focused on :

* The study of over 200 textiles from the prehistoric salt-mines, particular fibre, structural, dyestuff and element analysis.
* Comparison of the Hallstatt textiles with those excavated in the neighbouring village of Hallein-Duernberg.
* The influence of the Hallstatt textiles not only within the region but also within a indo-european context.

This symposium offered the possiblity for Austrian researchers to interact with fellow specialists from around the world and to take part in the on-going excavation work in the prehistoric mines.

The close co-operation with all parties involved in the study and excavation of prehistoric textiles, resulted in a successful and fruitful symposium. The willing support of the UNESCO Commission Austria at an early stage in this project was particularly beneficial and was a source of inspiration to all those involved.

Das archäologische Erbe einer über 7.000 jährigen Geschichte der Salzgewinnung in Hallstatt, die von der Steinzeit bis in die Gegenwart reicht, war einer der Gründe für die Aufnahme der Region Hallstatt 1997 in die Liste des UNESCO Weltkultur- und -naturerbes. Salz war aber nicht nur Würze - sondern damals eine der wenigen Möglichkeit Lebensmittel über längere Zeit zu konservieren und somit von eminenter Bedeutung für das Überleben. Der überaus lukrative Handel mit dem "weißen Gold" ließ den Ort in der "Hallstatt-Zeit" zu einer internationalen Metropole in den Alpen werden, wo man mit Kunstsinn die Kultur ferner Länder schätzte und Luxusgüter importierte.

Eine bedeutende Stelle nehmen dabei die Gewebefunde ein. Sie gehören weltweit zu den ältesten Textilien und zeichnen sich durch raffinierte Gewebstechniken und Feinheit aus. Sie sind bedeutende Zeugnisse der Alltagskultur vor 3.000 Jahren und ihr Musterschatz bis zum heutigen Tag von hohem ästhetischen Anspruch. Die Gesellschaft zur Förderung der Textil-Kunst-Forschung, das Naturhistorische Museum, Wien und die Universität für angewandte Kunst griffen als Organisatoren diese Themenstellung auf und waren sich mit den Zielvorgaben des 1. Symposium über Hallstatt-Textilien der vielschichtigen Aufgabenstellung bewußt:

** Neben der Erfassung und Bearbeitung der über 200 textilen Fundobjekte nach gewebs- und textiltechnischen Kriterien, sollte auch der Analyse der verwendeten Farbstoffe ein besonderes Augenmerk gewidmet werden.*
** Eingebettet in die archäologische Perspektive sollten die Textilien der Hallstattzeit in Kontext mit den Textilfunden aus dem benachbarten Hallein/Dürrnberg gebracht werden; diese Fragmente aus der La Tčne Zeit wurden unter sehr ähnlichen Fundumständen geborgen.*
** Der Versuch einer Standortbestimmung im geographischen und historischen Rahmen zu prähistorischen Textilfunden der benachbarten Kulturkreise, die in einen Dialog und Erfahrungsaustausch mit internationalen Experten führen.*

Nicht zuletzt sollte dieser internationale Erfahrungsaustausch für die teilnehmenden Studenten Ansporn sein, sich der Erforschung, dem Studium und der Konservierung von prähistorischen Textilien in verstärktem Maße zu widmen.

Ganz besonders möchte ich mich für die enge und intensive Zusammenarbeit bei den veranstaltenden und unterstützenden Institutionen und bei den zahlreichen ehrenamtlichen Helfern bedanken, die dieses erste Hallstatt-Textil-Symposium zu einem so erfolgreichen Abschluß führten. Die wohlwollende Förderung diese Projekts durch Fr. Gabriele Eschig von der Österreichische UNESCO Kommission und die Zusammenarbeit mit Dr. Mona Mairitsch, UNESCO, waren eine wichtige und frühzeitige Bestärkung, sich dieser lohnenswerten Aufgabe zu widmen.

Peter Bichler
Gesellschaft zur Förderung der Textil-Kunst-Forschung
Im Namen der Herausgeber

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Hallstatt – eine Einleitung zu einem sehr bemerkenswerten Ort

Anton Kern

Abstract

Die Salzgewinnung ab der frühen Jungsteinzeit macht die Region rund um Hallstatt zu einer der ältesten Kulturlandschaften in Österreich. Berühmt und bekannt ist der kleine Ort am Hallstätter See vor allem aber als namengebender Fundort für eine bedeutende Kulturepoche der europäischen Geschichte – der Älteren Eisenzeit. Zeitlich umfasst das bekannte prähistorische Gräberfeld die gesamte Hallstattkultur von ca. 800 v. Chr. bis 450/400 v. Chr. und weist dadurch ein weites Spektrum an Funden auf.

Production of salt from early Neolithic on is the cause to one of Austria's oldest cultural landscapes in the region around Hallstatt. This little village near to the Lake Hallstatt is also famous to be the eponymous place for an important period in Europe's history, for the Early Iron Age. The remarkable prehistoric graveyard spans the complete Hallstatt-Culture from around 800 until 450/400 B.C. and shows a wide spectrum of archaeological finds.

Einleitung

Eisen war das neue, vieles verändernde Element im Zeitraum zwischen 800 und 450 vor Christus, und dennoch trägt diese Ältere Eisenzeit als Bezeichnung keinen markanten Fundplatz der frühen Eisenindustrie. Es war das Salz – Hall -, das dieser frühen Epoche der europäischen Kulturgeschichte den Namen gab, benannt nach dem Fundort Hallstatt am südwestlichen Ende des Hallstätter Sees, wo in einem engen Hochtal (Fig. 1 und Plate 2) über dem kleinen Ort ab der Mitte des 19. Jahrhunderts die faszinierenden archäologischen Funde zu Tage kamen.

Seit dieser Zeit ist Hallstatt das Ziel verschiedenster wissenschaftlicher Untersuchungen, und nach über 150-jähriger Forschungsarbeit liegen umfassende, teilweise überraschende Erkenntnisse über eine der interessantesten Mikroregionen Europas vor. Schon lange vor der Hallstattkultur verstand es der Mensch, in diesem unwirtlichen alpinen Gebiet Salz zu fördern. Die ersten Anfänge reichen bis in das 5. Jahrtausend vor Christus zurück, eine Haue aus Hirschgeweih und mehrere Steinbeile belegen den Versuch, in dieser Frühzeit der mitteleuropäischen Besiedelung an das begehrte Salz zu gelangen. Noch wissen wir nicht, ob die Menschen der Jungsteinzeit wirklich an das feste Kernsalz kamen; die oben beschriebenen Werkzeuge wurden „nur“ im ausgelaugten Haselgebirge – dem wasserundurchlässigen Schutzmantel für das Salz, bestehend aus Ton, Lehm und Erde – 60 m tief bei Ausbauarbeiten in einem Stollen gefunden. Der Salzabbau im Berg ist ab dem 14. Jahrhundert vor Christus nachgewiesen. Am Ausklang der Mittleren Bronzezeit zeigt sich eine bereits voll

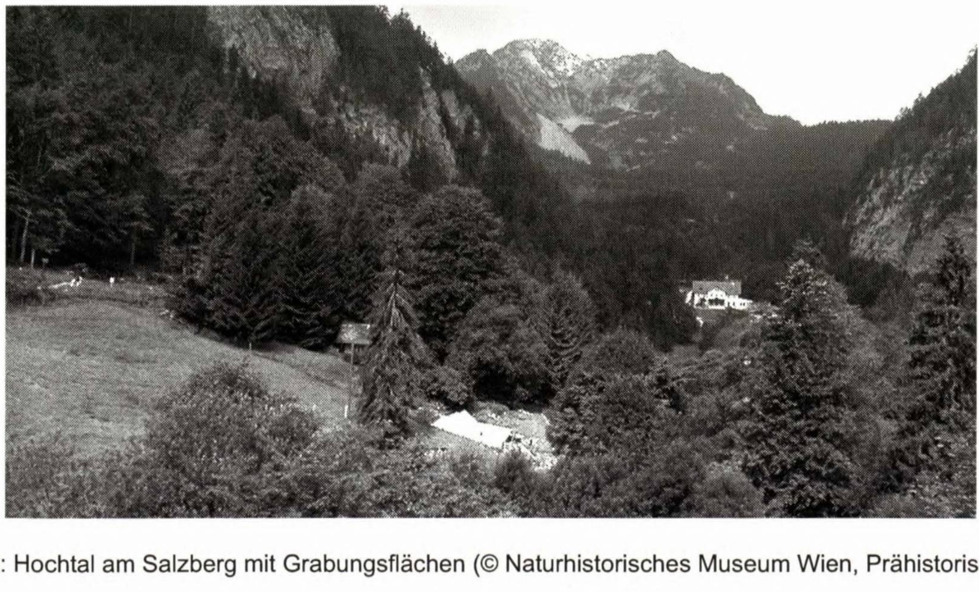

Fig. 1: Hallstatt: Hochtal am Salzberg mit Grabungsflächen (© Naturhistorisches Museum Wien, Prähistorische Abt.).

entwickelte, ausgereifte Technik, Salz im großen Stil zu fördern. Während der Hallstattkultur erreichte die Gewinnung von Salz einen ihrer Höhepunkte, jedoch durch eine Umweltkatastrophe scheint diese wirtschaftliche Blüte im 4. vorchristlichen Jahrhundert ihr jähes Ende gefunden zu haben. Erst in den letzten hundert Jahren vor Christus gelingt es den keltischen Bewohnern dieser Region, die Salzgewinnung wieder aufzunehmen, wobei aber andere Bereiche des Hochtales zum Abbau erschlossen werden. Wie die reichen Funde aus Hallstatt-Lahn schließen lassen, haben auch die Römer bzw. romanisierte Kelten in den folgenden Jahrhunderten Salz im Hochtal gefördert, erst ab der Völkerwanderungszeit versiegen die Nachweise einer Salzindustrie. Die Geschichte des „modernen“ Salzbergbaues beginnt mit dem Hochmittelalter, ab dem bis heute im Laugverfahren das „weiße Gold“ aus dem Hallstätter Salzberg gewonnen wird.

Forschungsgeschichte

Kein Archäologe, sondern ein Bergmeister legte 1846 den Grundstein für die nachfolgenden wissenschaftlichen Tätigkeiten. Unter Johann Georg Ramsauer (Fig. 2a) wurden ab diesem Jahr bis 1863 nahezu 1.000 Gräber freigelegt, die – wie sich später herausstellte – die gesamte Zeitspanne von ca. 400 Jahren der Hallstattkultur umfassten. Ramsauer erkannte sofort die Wichtigkeit der Fundstücke und nahm unverzüglich Kontakt zu Museen in Linz und Wien auf, die ihm auch erste Anweisungen zum Umgang mit den „Antiken“ übermittelten. Die umfassende Ausbildung, die Ramsauer in der Salinenschule genossen hatte, kam ihm nun zu Gute und er dokumentierte und beschrieb sowohl die einzelnen Funde wie auch – außergewöhnlich für die damalige Zeit – die Fundsituationen der einzelnen Gräber. Von mehreren Bestattungen ließ Ramsauer Zeichnun-

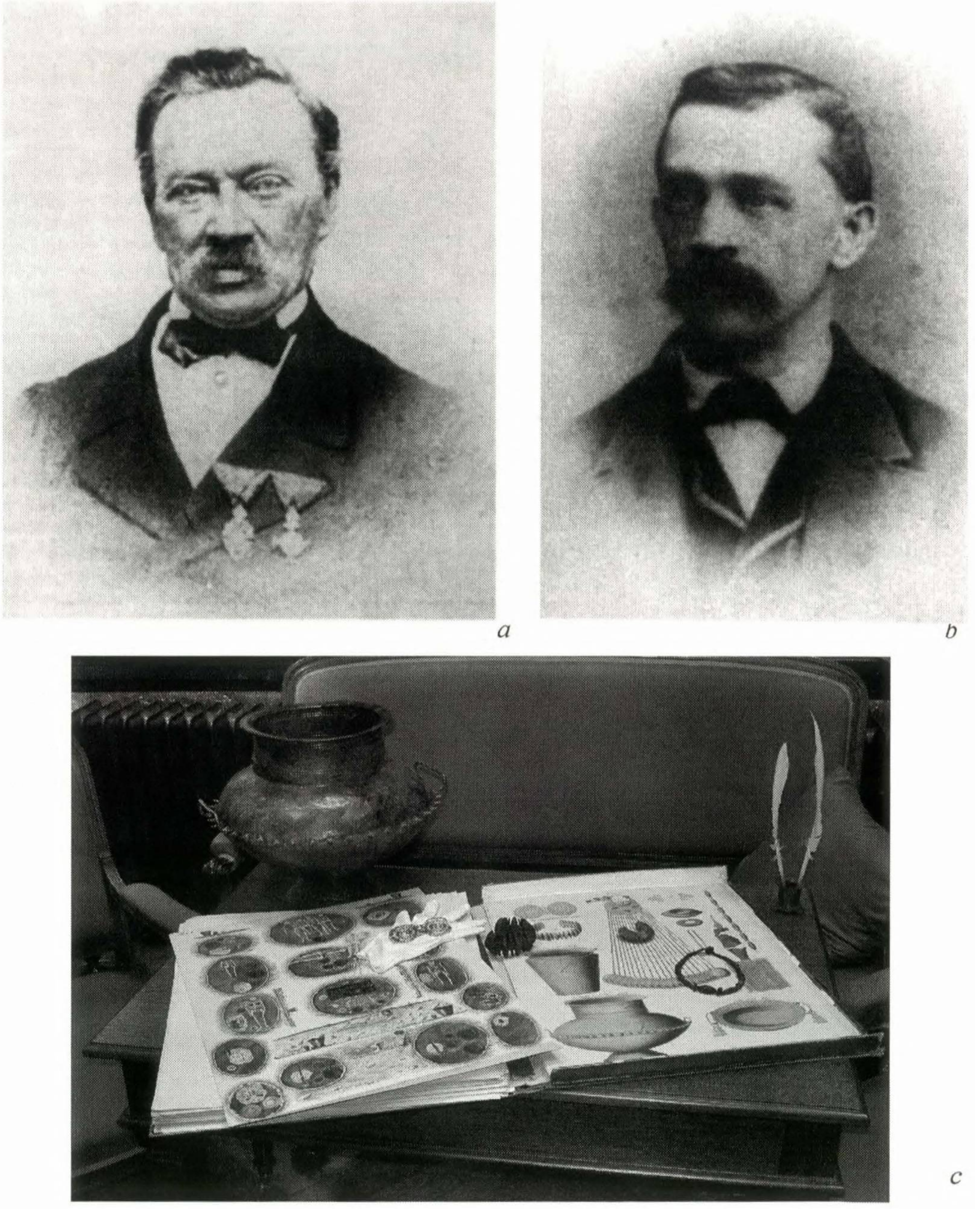

Fig. 2: Forscher in Hallstatt: a: Johann Georg Ramsauer, der erste Ausgräber des Hallstätter Gräberfeldes. – b: Isidor Engl, Ausgräber und Zeichner. – c: Ramsauerprotokoll mit frühen Funden (© Naturhistorisches Museum Wien, Prähistorische Abteilung).

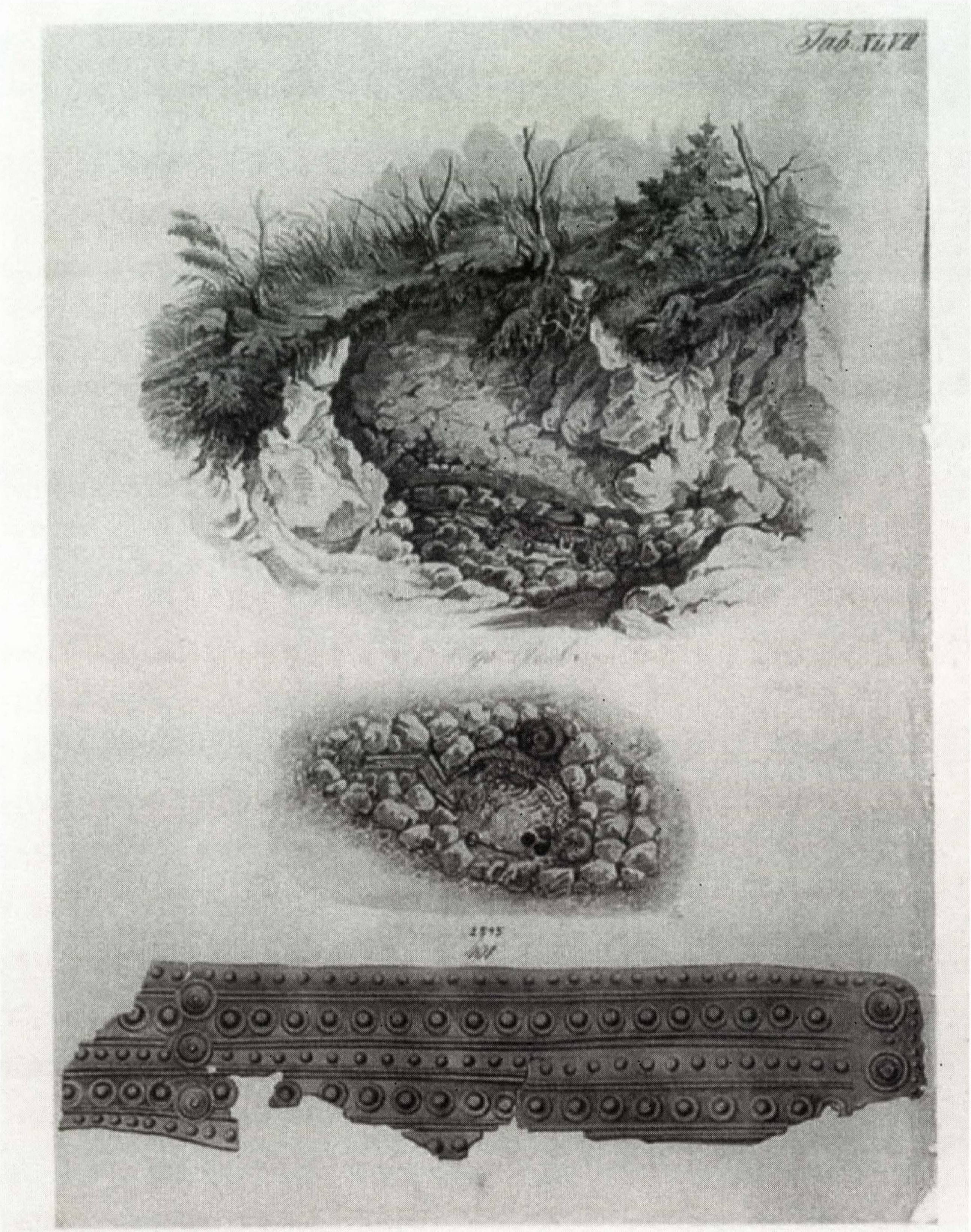
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Fig. 3: Gräberfeld Hallstatt: Aquarellmalerei von I. Engl (© Naturhistorisches Museum Wien, Prähistorische Abteilung).

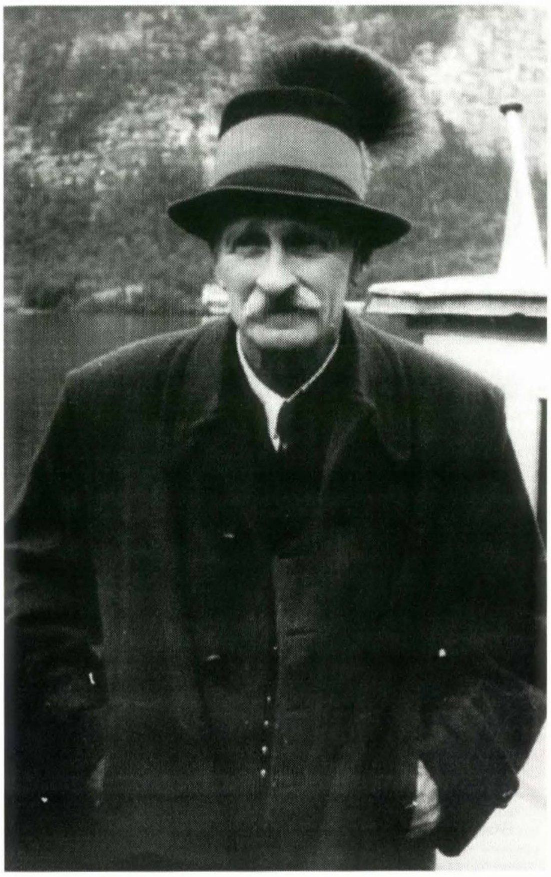


Fig. 4: Friedrich Morton, Ausgräber am Gräberfeld und in Hallstatt-Lahn (© Naturhistorisches Museum Wien, Prähistorische Abteilung).

gen anfertigen, die dann als Aquarelle umgesetzt wurden (Fig. 3 und Plate 1). So blieben der Urgeschichtsforschung wertvolle Dokumente zur Entdeckung des Gräberfeldes in breitem Umfang erhalten. 1863 dachte Ramsauer, das Gräberfeld sei erschöpft, da an den damaligen Randbereichen die Dichte der Gräber deutlich abnahm. Dies stellte sich jedoch schon kurze Zeit später als Irrtum heraus, als nachfolgende Ausgräber wieder im Gräberfeld fündig wurden, aber nicht mehr so erfolgreich waren wie Ramsauer. Einer der bedeutenderen Epigonen, Isidor Engl (Fig. 2b), hatte schon unter Ramsauer gearbeitet und war damals für die meisten Bilddokumentationen verantwortlich. Er setzte die Tradition Ramsauers fort, und auch von ihm sind uns wissenschaftlich nutzbare Aufzeichnungen erhalten.

Durch erste Publikationen von Friedrich Simony und Eduard v. Sacken fand die Fachwelt Zugang zum umfassenden Fundmaterial und 1874 verwendete Hans Hildebrand erstmals den Begriff *„groupe de Hallstatt"* für den Zeitraum der Älteren Eisenzeit in Mitteleuropa.

1877 beginnt auch die enge Verbindung zwischen Hallstatt und dem Naturhistorischen Museum in Wien, als der Erste Intendant des Hauses, Ferdinand v. Hochstetter, Ausgrabungen im Hochtal durchführte. Ebenfalls erfolgreich verliefen die archäologischen Untersuchungen unseres Hauses 1886 unter Josef Szombathy, der in der Steinbewahrersölde über 10 Gräber freilegte.

Zu Beginn des 20. Jahrhunderts ließ die Großherzogin von Mecklenburg auf den Wiesen des Hochtales arbeiten, das Inventar von 26 Gräbern kam nach ihren Tod in den Kunsthandel und wurde vom Peabody-Museum der Harvard-Universität in Cambridge, Massachusetts, erworben.

Die letzten erfolgreichen „Altausgrabungen" fanden unter Friedrich Morton (Fig. 4) in den Jahren 1937 bis 1939 statt, wobei beachtliche 61 Gräber vor allem der jüngeren Belegungsphase des Gräberfeldes als wissenschaftliches Ergebnis verblieben.

Die neuen Untersuchungen auf dem Gräberfeld begannen 1994 mit einer Rettungsgrabung am Nordrand des bekannten Friedhofes, als eine neue Druckleitung im Hochtal verlegt wurde. Seitdem finden regelmäßig Ausgrabungen im Gräberfeld statt, bis 2003 erbrachten die Arbeiten über 70 Gräber. Gemeinsam mit den archäologischen Untersuchungen im Berg stellen die Tätigkeiten im prähistorischen Friedhof einen sehr wichtigen Forschungsschwerpunkt der Prähistorischen Abteilung dar, was zuletzt auch zur Errichtung einer Außenstelle in der ehemaligen alten Bergschmiede führte. Mit Unterstützung der Salinen Austria konnte ein Industriebau des späten 19. Jahrhunderts saniert und ausgebaut werden und dient nun als Basis für sämtliche Arbeiten im Gebiet um Hallstatt (Fig. 5).

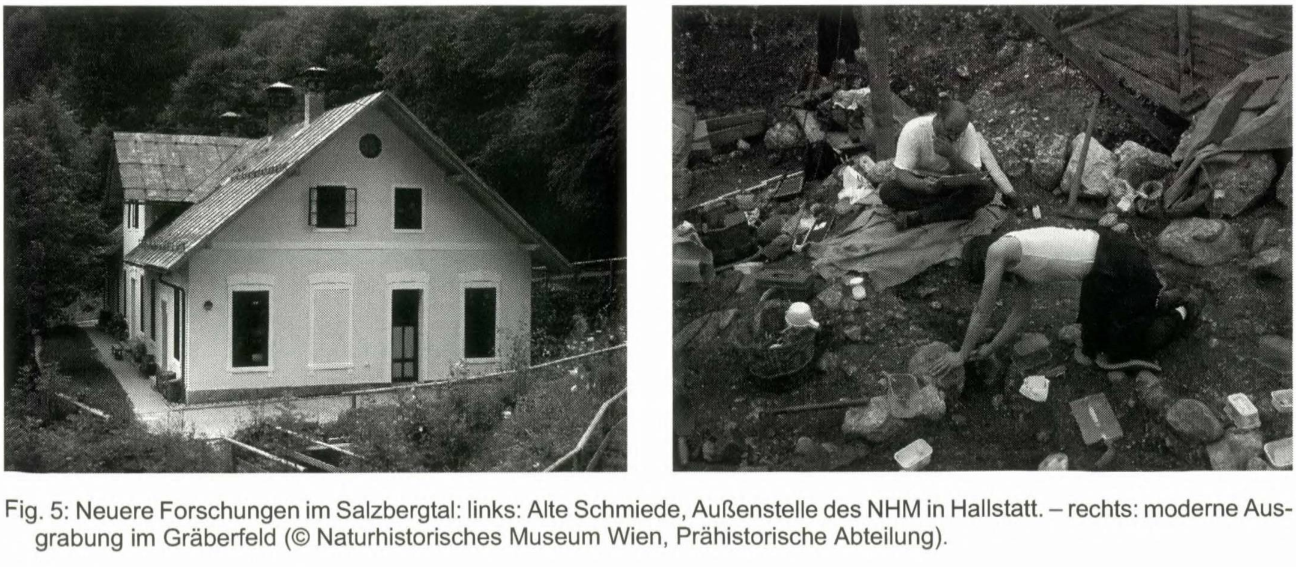
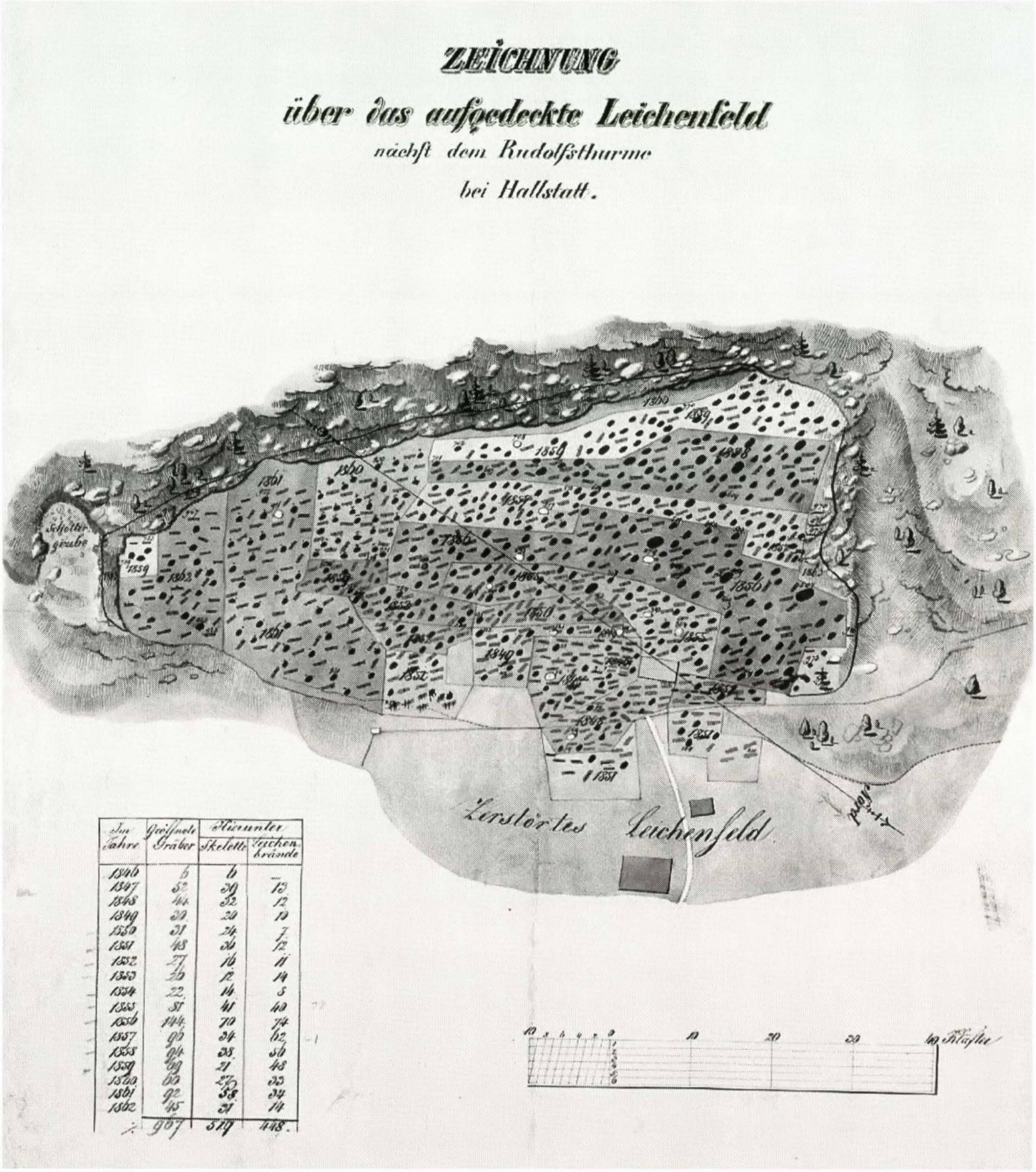


Fig. 5: Neuere Forschungen im Salzbergtal: links: Alte Schmiede, Außenstelle des NHM in Hallstatt. – rechts: moderne Ausgrabung im Gräberfeld (© Naturhistorisches Museum Wien, Prähistorische Abteilung).



Im Jahre	Geöffnete Gräber	Hierunter Skelette	Hierunter Leichenbrände
1846	6	6	–
1847	52	39	13
1848	44	32	12
1849	39	29	10
1850	31	24	7
1851	48	36	12
1852	27	16	11
1853	26	12	14
1854	22	14	8
1855	81	41	40
1856	144	70	74
1857	96	34	62
1858	94	38	56
1859	69	21	48
1860	60	27	33
1861	92	58	34
1862	45	31	14
./.	907	519	448.

Fig. 6: Hallstatt: Plan des Gräberfeldes im Salzbergtal von Johann Georg Ramsauer (© Naturhistorisches Museum Wien, Prähistorische Abteilung).

Das Hallstätter Gräberfeld

Mit den nun nahezu 1.500 Gräbern zählt das Hallstätter Gräberfeld (Fig. 6) zu den großen Friedhöfen der Hallstattkultur. Auf engstem Raum am Ostausgang des Hochtales drängen sich dicht an dicht die einzelnen Bestattungen, wobei es oft zu Überschneidungen, Überlagerungen und Zerstörungen älterer Gräber durch jüngere kommt. Sehr deutlich zeigten sich diese Befunde in den letzten Arbeiten, wo auf rund 150 m^2 über 70 Grabanlagen zum Vorschein kamen. Durch die neuen Erkenntnisse lassen sich auch mehrere zweifelhafte „Grabzusammensetzungen“ Ramsauers erklären, die ebenfalls durch vermischte Gräber entstanden waren. Der schon durch die Altgrabungen vorliegende birituelle Charakter in der Grablegung bestätigte sich, nur veränderte sich das Verhältnis von Brand- zu Körperbestattungen von 45:55 bei den ‚Altgräbern' auf ca. 60:40 bei den Neuausgegrabenen.

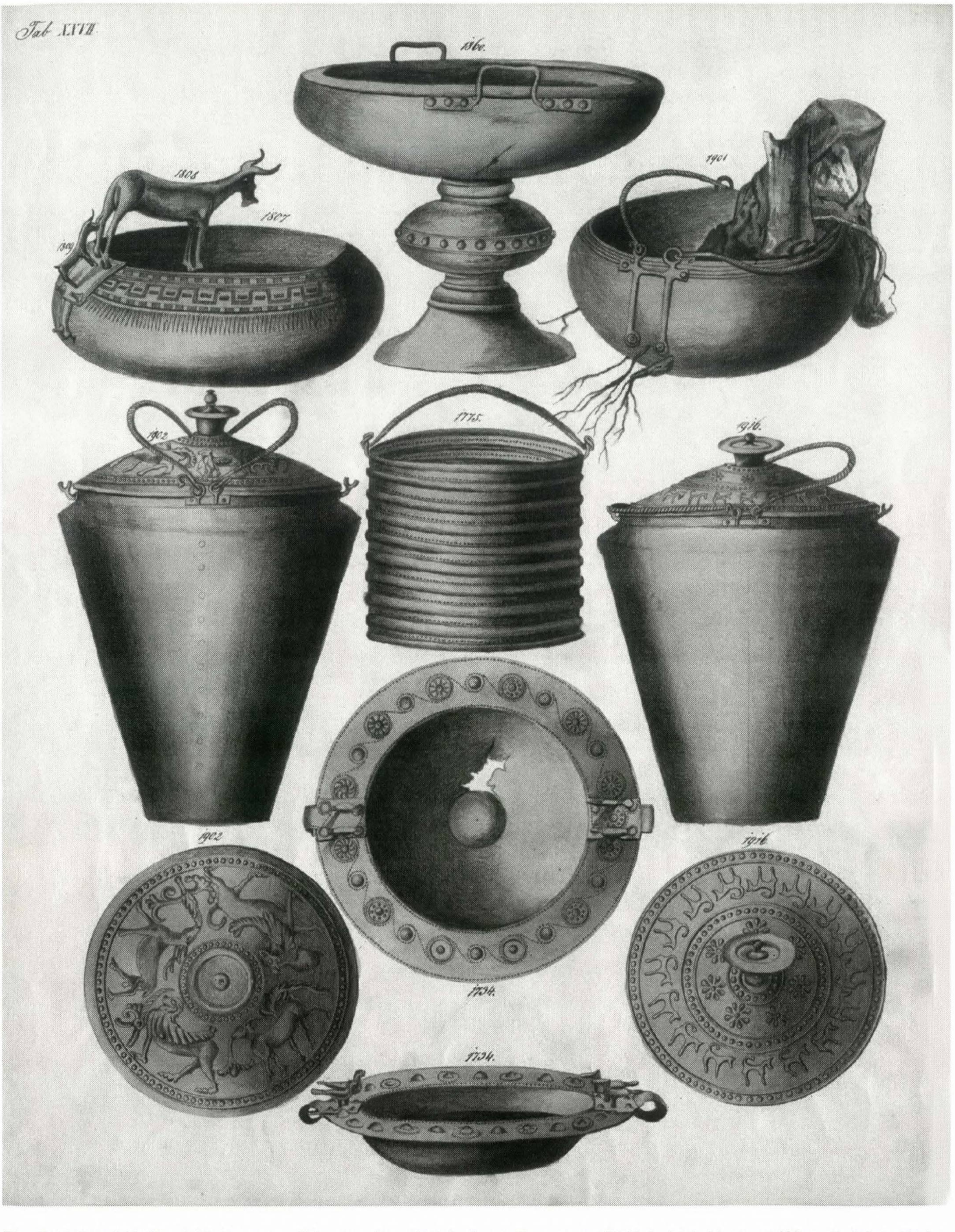


Fig. 7: Hallstatt Gräberfeld: Bronzegefäße aus dem Protokoll von Ramsauer (© Naturhist. Museum Wien, Prähist. Abt.).

Auch die Beobachtung der sozialen Differenzierung im Bestattungsmodus konnte weiterhin bestätigt werden, im Verhältnis zu den Körperbestattungen zeichneten sich die Brandbestattungen durch reichere Beigaben aus. Hatte vor allem Ramsauer reiche Brandgräber mit zahlreichen Bronzegefäßen im Fundgut (Fig. 7), so wird die Gruppe der reichen Brandgräber (Plate 1/3) in den jüngst gegrabenen Flächen durch üppig ausgestattete Keramikservice ge-

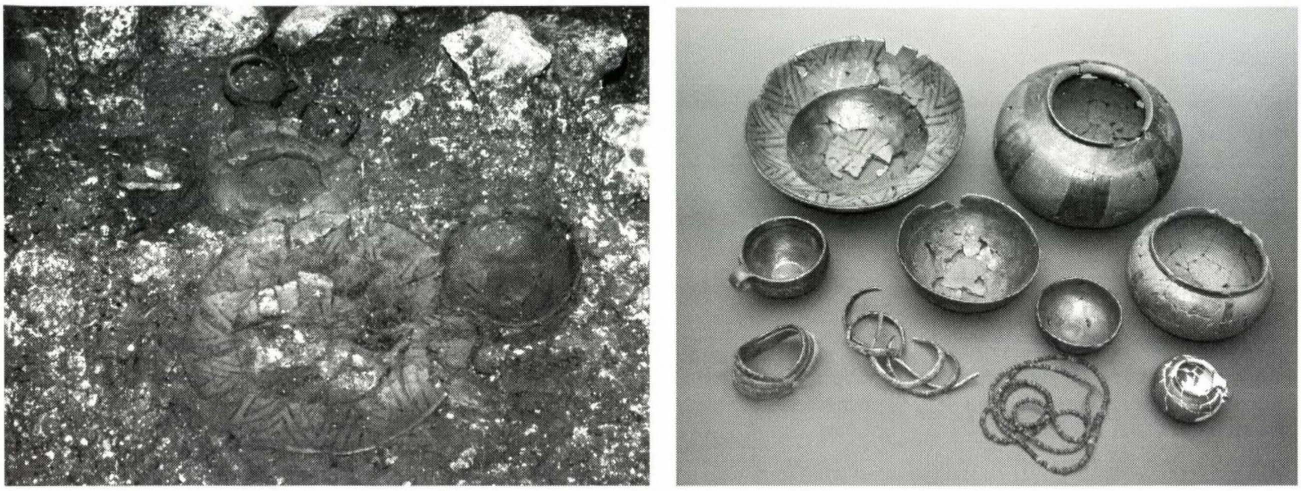


Fig. 8: Hallstatt Gräberfeld, Brandgrab 18: links: während der Freilegung. – rechts: nach der Restaurierung (© Naturhistorisches Museum Wien, Prähistorische Abteilung).

prägt, wobei bis zu 25 Tongefäße als Proviantgeschirre beigegeben wurden (Fig. 8). Auffallend ist nach wie vor die äußerst geringe Anzahl an Urnenbestattungen, wobei auch hier das Verhältnis zwischen Alt- und Neugrabungen von 5:3 bei über 1.400:ca. 75 Gräber neu zu bewerten ist. Die primäre Ausrichtung der Körperbestattungen (Plate 1/4) ist West-Ost, der Tote ruht in Rückenlage, der Schädel ist nach Osten gerichtet. Dazu gibt es Abweichungen in der Orientierung auf Süd-Nord, wo der Kopf ebenfalls nach Nord ausgerichtet ist. Bei den Neugrabungen konnte diese Anomalie bei einer Gruppe bestehend aus fünf Frauen beobachtet werden, die auf relativ engem Raum bestattet waren. Zu diesen Graborientierungen gibt es weiters Abweichungen in der Körperhaltung, hauptsächlich durch abweichende Lagen der Extremitäten, z.B. eine Bestattung in extremer Hockerstellung im Jahr 2002.

Im Vergleich zu anderen Gräberfeldern der Hallstattkultur können die Bestatteten als reich bezeichnet werden. Ausgestattet mit zahlreichen Proviantgefäßen, Mischgefäßen aus Bronze, oder einzigartig angefertigten Schalen und Schüsseln, spiegelt sich in den Beigaben das Vermögen im realen Leben. Dazu gesellen sich luxuriöse Gegenstände, anfertigt aus seltenen und wertvollen Rohmaterialien wie Elfenbein, Bernstein und Glas.

In Hallstatt gibt es eine Anzahl kunstvoller Elfenbeinschnitzereien, die schönsten Stücke umfassen die so genannten ‚Pilzknäufe' (Abb. 9a) für das typische Hallstattschwert, die üblicherweise entweder aus Holz oder aus Bronze angefertigt waren. Aus dem Gräberfeld sind uns wahre Meisterwerke erhalten, die darüber hinaus auch noch mit kunstvollen Einlagen aus Bernstein verziert sind. Ob das Elfenbein seinen Ursprung in Afrika oder in Asien hat, kann möglicherweise demnächst mit einer Isotopenuntersuchung geklärt werden; Handel über Zwischenstationen hinweg ist aber in beiden Richtungen möglich. Importierte Glasgefäße aus dem Caput Adriae (Abb. 9b) zäh-

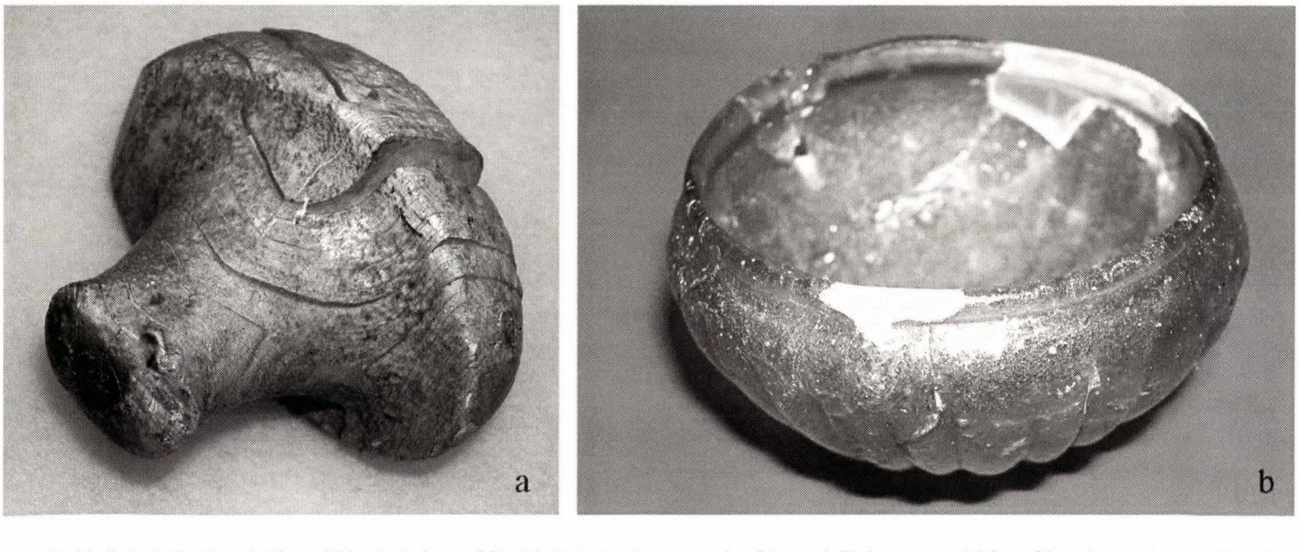


Fig. 9: Hallstatt Gräberfeld: a: Elfenbeinknauf für Hallstattschwert. – b: Glasschälchen, um 600 v. Chr., Import aus Oberitalien (© Naturhistorisches Museum Wien, Prähistorische Abteilung).

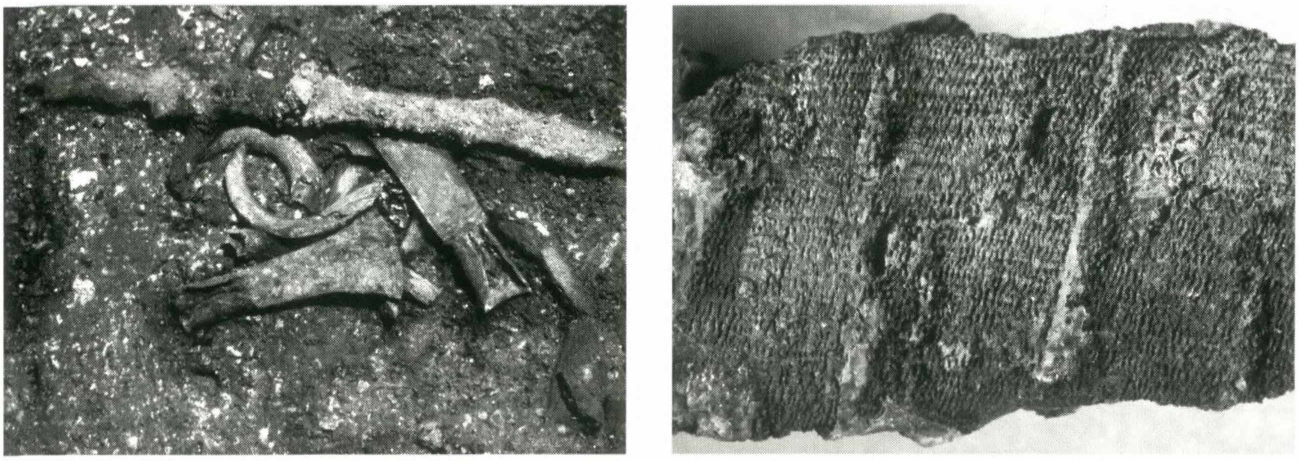


Fig. 10: Hallstatt Gräberfeld: links: Brandgrab eines Kriegers mit Eisenschwert, Beilen aus Bronze und mächtigen Eberhauern – rechts: Detail des Eisenschwertes mit durch die Oxidation des Metalles konservierten Geweberesten (© Naturhistorisches Museum Wien, Prähistorische Abteilung).

len zu den ältesten ihrer Art im zentralen Europa nördlich der Alpen.

In den Gräbern finden sich jedoch nur Teile des ursprünglichen Reichtums, denn fast alles, was aus organischen Stoffen bestand, ist vergangen, zerfallen und verrottet. Nur sehr wenig wissen wir z.B. über die Stoffe und den daraus angefertigten Kleidern; vereinzelte Funde aus Fürstengräbern der Hallstattkultur an anderen Fundplätzen beweisen aber eine weite Bandbreite an kostbaren Textilien und kunstvoll angefertigten Kleidungsstücken. Aus Hallstatt selbst sind – im Gegensatz zu den reichen Textilfunden aus dem Salzbergwerk – aus dem Gräberfeld keine Textilreste der Bekleidung erhalten geblieben, jedoch an manchen Schwertern und Dolchen aus Eisen sind durch die Oxidation des Metalls Gewebestrukturen einwandfrei konserviert (Fig. 10). Ursprünglich dürften möglicherweise öl- oder fettgetränkte Bänder um die Waffen gewickelt worden sein, um diese vor allzu schneller Verrostung zu bewahren.

Genau so bedeutend wie die überaus differenzierte Zusammensetzung des Fundgutes ist die Laufzeit des Gräberfeldes, die die gesamte Hallstattkultur von ihren Anfängen um 800 vor Christus bis zum Ende um 450/400 vor Christus umfasst. So beinhalten die ältesten Gräber noch Formen, die der ausklingenden Bronzezeit zuzuordnen sind, während die jüngsten Gräber bereits der Stufe La Tène A angehören.

Den Reichtum in ihren Gräbern haben die Menschen im prähistorischen Hallstatt einzig allein dem Salz zu verdanken. Dieser Schatz aus dem Innern der Erde prägte nicht nur das Leben der Menschen in der Hallstattzeit, sondern auch schon früher und dann auch später. Eine der Aufgaben der Archäologie ist es, diese einzigartige Lebenssituation in einem extremen Gebiet zu erforschen und aus dem großartigen Fundus an organischen und anorganischen Hinterlassenschaften die Geschichte des Hochtales über Hallstatt – zumindest teilweise – zu rekonstruieren.

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EPOCHEN - ZEITSTUFEN		DATIERUNG	HALLSTATT
RÖMISCHE KAISERZEIT	Spätrömische Kaiserzeit	284 - 488	Hallstatt - Lahn: Siedlung Gräber
	Mittelrömische Kaiserzeit	180 - 284	Hallstatt - Lahn: Siedlung Gräber
	Frührömische Kaiserzeit	15 v. Chr. - 180 n. Chr.	Hallstatt - Lahn: Siedlung Gräber
EISENZEIT	Jüngere Eisenzeit Latènekultur	450 - 15 v. Chr.	Dammwiese - Plassen: Siedlung Bergbau, ab ca. 100 v. Chr.
	ÄLTERE EISENZEIT HALLSTATTKULTUR	800 / 750 - 450	Salzberg: Bergbau Gräber
BRONZEZEIT	Späte Bronzezeit	1250 - 800 / 750	Salzberg: Bergbau Siedlung (Blockbauten)
	Mittlere Bronzezeit	1600 - 1250	Salzberg: Bergbau, ab ca. 1400 v. Chr. Siedlung (Blockbauten)
	Frühe Bronzezeit	2200 / 2300 - 1600	
JUNGSTEINZEIT NEOLITHIKUM	Spätneolithikum	3900 - 2200 / 2300	
	Frühneolithikum	5000 / 6000 - 3900	Salzberg: Einzelfunde: ca. 5000 v. Chr. Hirschgeweih - Haue Steinbeile

Fig. 11: Zeit- und Fundtabelle für Hallstatt (© Naturhistorisches Museum Wien, Prähistorische Abteilung).

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Curriculum vitae

Geboren 1957 in Mistelbach, Niederösterreich. Zunächst Lehramtsstudium Englisch und Geschichte, ab 1978 Ur- und Frühgeschichte sowie Geschichte, Schwerpunkt frühmittelalterliche Geschichte, Promotion 1987 an der Universität Wien.

Ab 1976 Teilnahme an zahlreichen archäologischen Ausgrabungen und Notbergungen der Universität Wien, des Niederösterreichischen Landesmuseums und des Bundesdenkmalamtes, zwischen 1985 und 1990 wissenschaftlicher Angestellter am Forschungsprojekt „Kamptalprojekt" des FWF, unter der Leitung von Univ.-Prof. Dr. H. Friesinger, Vorstand des Instituts für Ur- und Frühgeschichte der Universität Wien. Freiberuflicher Wissenschafter und Leiter der Grabungen der Stadtgemeinde Tulln, auf dem Oberleiserberg und in Thunau bei Gars am Kamp. Herbst 1990 bis Dezember 1991 im Planungsteam des Kulturtourismus-Projektes "Kulturpark Kamptal".

Ab 1991 in der Prähistorischen Abteilung des Naturhistorischen Museums in Wien, ab 1. Oktober 2001 Direktor dieser Abteilung. Seit 1993 Durchführung und Leitung der Ausgrabungen am prähistorischen Gräberfeld in Hallstatt.

Die prähistorischen Salzbergbaue in Hallstatt und ihre Textilreste

Hans Reschreiter

Abstract

In Hallstatt gibt es eine 7.000-jährige Salzproduktionstradition. Aus der Bronzezeit und der Eisenzeit sind die Überreste der riesigen Abbauhallen bekannt, in denen noch heute, durch das Salz bestens konserviert, der prähistorische Betriebsabfall zu finden ist. Neben gebrochenem Werkzeug und unzähligen abgebrannten Kienspänen beinhaltet dieses sogenannte „Heidengebirge" auch viele sehr gut erhaltene Textilreste.

Hallstatt is one of the major „salt-sites" in the eastern Alps. Its importance is mainly based on the 7.000 years old tradition of salt-production. Bronze Age and Early Iron Age mining activities resulted in enormous exploitation galleries. The mining activities led to the formation of layers called "Heidengebirge" enclosing broken tools, countless spills of spruce and fir used as torches, food remains and many textile fragments.

Auf den ersten Blick hat Hallstatt mit Textilien nichts zu tun. Mit dem Namen verbindet man vielmehr Salz, Archäologie sowie eine ganze Epoche der europäischen Geschichte[1].

Alles begann mit einer steilen Wiese am Hallstätter Salzberg (Plate 2), die zwischen dem 8. und 4. Jahrhundert v. Chr. als Friedhof genutzt wurde. Auf dem Areal dieses urgeschichtlichen Bestattungsplatzes stieß man bei neuzeitlichen Bodeneingriffen immer wieder auf „Antiquitäten". Die ersten Berichte über derartige „Auffindungen" gibt es bereits am Anfang des 18. Jahrhunderts[2].

Der erste, der erkannt hatte, dass diese Objekte nicht zufällig und regellos im Boden „wachsen", und stattdessen die Relikte eines prähistorischen Friedhofs sind, ist der Bergmeister Johann Georg Ramsauer[3]. Ein Großteil der Ausgrabungen im weltberühmten Gräberfeld ist ihm zu verdanken. Seine exakte naturwissenschaftliche Ausbildung als Bergmann, seine Beobachtungsgabe, seine Faszination und nicht zuletzt sein Ehrgeiz und sein Geltungsdrang bewirkten, dass er bereits vor über 150 Jahren archäologische Ausgrabungen auf hohem Niveau durchführte. Die außergewöhnlichen Funde machten Hallstatt bald in der Fachwelt bekannt und schlussendlich zum namengebenden Fundort der älteren Eisenzeit.

Bei seinen Arbeiten im Gräberfeld stieß Ramsauer nie auf prähistorische Stoffreste. Dennoch liegt der Schlüssel zu den Textilfunden aus dem Bergwerk im Gräberfeld. Bei seinen Nachforschungen im Friedhof stieß er sehr häufig auf grün patinierte Bronzeobjekte – die Grabbeigaben (siehe Beitrag Kern, Fig. 7). Und genau diese Grünfärbung kannte er auch von manchen Stellen des Heidengebirges im Bergwerk. Er schloss, dass das Grün im Berg auch auf verwitterte Bronze zurückzuführen sei und begann daher an einer dieser „grünen Stellen" im Berg gezielt nach „Alterthümern" zu suchen. Es war dies die erste intentionelle Fundgewinnung in der Grube.

Ramsauer wählte für seinen Versuch das Kernverwässerungswerk. Er ließ nicht mit Bergeisen nach den Funden suchen, sondern ein Spritzwerk wurde eingerichtet. Dabei wurde ein feiner Wasserstrahl an die Wand gerichtet. Dieser löste das Salz langsam auf, alle darin enthaltenen Einschlüsse wurden freigeschwemmt und konnten aufgesammelt werden.

Das detaillierte Protokoll mit Abbildungen Ramsauers dieser Aktion aus dem Jahr 1849 blieb erhalten (Plate 4)[4]: *„Von 12ten bis Ende August 1849 aufgefunden das Bruchstück eines thönernen / Topfes mit Prägung No 9, zwei Stück mit Menschenknochen no 10, Ein Stroh / geflechte mit Holzstücken 11 alles im reichen Salzgebirge. No 12 Eine 13/4 Zoll / breite Halsschleife deren Stoff halb von Wollen und halb von Pferdeharren besteht. / No 13, 14, 15, 16, 17 und 18 mehrere Stücke verschiedenartige Wollenstoffe / deren Arbeit von Kennern bewundert, den neuesten Wollstoffen in der / Bearbeitung gleich gehalten, und wenn nicht diese in ganzen Salzgebirge einge / schlossen wären, dieß als eine Täuschung erklärt würde.*" Auch über 150 Jahre später haben diese ersten Textilfunde aus dem Bergwerk nichts von ihrer Faszination eingebüßt.

Einige Nachfolger Ramsauers versuchten, an seine Erfolge anzuknüpfen, sowohl im Gräberfeld, als auch im Bergwerk – meist nur mit bescheidenem Erfolg. Immer wieder aber waren es Bergleute, die die Archäologie im und am Berg vorantrieben oder zumindest am Leben erhielten. So waren Stapf und Hutter die ersten, die versuchten, die in der Grube verstreuten Fundstellen zu katalogisieren und zu ordnen[5]. Ihre Gruppeneinteilung wurde dann von Aigner und Schauberger ausgebaut und ergänzt[6]. Eine ausgedehnte Untersuchung eines in sich zusammengestürzten bronzezeitlichen Schachtes im Appoldwerk förderte weitere Textilreste zu Tage[7].

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[1] Letzte Zusammenstellungen des aktuellen Forschungsstandes in: Barth und Lobisser 2002. – Stöllner 1999.

[2] Riezinger 1995.

[3] Siehe Beitrag A. Kern.

[4] Barth 1990.

1960 war für die Archäologie im Berg ein Richtung weisendes Jahr. Angespornt durch die Vorarbeiten von Schauberger und Kromer (Die erste komplette Vorlage aller Funde aus dem Gräberfeld)[8], und durch das Interesse der Betriebsleitung, wurde vom Naturhistorischen Museum Wien mit gezielten archäologischen Ausgrabungen in der Grube begonnen.

Als Stelle wurde das Kilbwerk gewählt, das durch den Fund des „Mannes im Salz“ 1734 zu Berühmtheit gelangt war. In der Schilderung der Auffindung dieser prähistorischen Bergmannsleiche, haben wir die älteste erhaltene Beschreibung von Textilien aus dem Hallstätter Salzberg: „...... *nebst deme hat man in solchem Nidergang Himmel einen nadierlichen Cörber von ainem Totten menschen gesehen, welcher muedtmaslich und deme ansechen nach, vor mehr als 400 Jahren mueß verschidtet sein worden, massen Selbiger in des Gebirg föllig verwachssen, doch sicht man noch von seinem rockh etlich flöckh, wie auch die S.V. Schuech an denen füeßen und dises Verursachet in der wöhr ain seehr yblen Geruch, welcher sich Schon vor disem nidergang hat verspiren Lassen.* .....“[9] Von der Kleidung und den Schuhen dieses hallstattzeitlichen Bergmannes blieb leider nichts erhalten – sie wurden gemeinsam mit dem Toten im Friedhof bestattet und sind inzwischen längst vergangen.

Als die Grabungen 1960 begannen, war die Datenbasis recht bescheiden. Man kannte drei Konzentrationen von Fundpunkten in der Grube und ging mit Sicherheit davon aus, dass diese Bergbauspuren mit dem Gräberfeld zeitlich gleichzusetzen seien, d.h. in die Hallstattzeit zu datieren sind.

Da durch den Laugwerksbetrieb das Salz aus dem kernigen Heidengebirge gelöst wird, bleiben nur die Funde, vermischt mit dem unlösbaren Lehm als Werkslaist im Laugwerk liegen, wodurch eine Anreicherung an Funden entsteht. Aus diesem Grund konnten im Kilbwerk – die Fundanreicherungen waren durch den barocken Laugwerksbetrieb verursacht worden – bereits in den ersten Grabungsjahren eine beträchtliche Anzahl neuer Textilreste geborgen werden.

Sehr bald wurde versucht, die Gliederung der Funde in der Grube typologisch zu verfeinern und die bisherige Einteilung durch neu entwickelte naturwissenschaftliche Methoden (Dendrochronologie und ^{14}C-Datierung) zu überprüfen.

Nach dem Kilbwerk stellte das Grünerwerk lange einen Schwerpunkt der Untersuchungen in Hallstatt dar. Bereits die ersten ^{14}C-Daten waren eine große Überraschung. Sie belegten das bronzezeitliche Alter dieses Schachtbaues. Die Fund- und Befundumstände verhinderten zwar die Entdeckung neuer Textilien, ermöglichten jedoch die Struktur des bronzezeitlichen Bergbaues in Hallstatt über weite Strecken zu klären.

Angeregt durch die Funde aus Ramsauers Spritzwerk von 1849 wurde beschlossen, das Kernverwässerungswerk erneut aufzufahren. Im Heidengebirge wurden viele weitere Textilreste entdeckt und das erste Mal ein kompletter Querschnitt durch eine hallstattzeitliche Abbauhalle ergraben. Es handelt sich dabei um eine beinahe waagrechte Halle, die vom (heutigen) Stügerwerk über das Kernverwässerungswerk mindestens bis zum Kilbwerk reicht und damit mehr als 170 m lang ist. Außergewöhnlich war jedoch nicht die Länge, sondern die Höhe von bis zu 20 m bei einer Breite von nur 10 bis über 20 m.

Von den bekannten Fundpunkten her ist die Versuchung groß, zumindest drei dieser riesigen Abbauräume übereinander zu postulieren[10].

1990 wurde der Schwerpunkt der Forschungsarbeit in das Christian-Tuschwerk, alter Grubenoffen verlegt. Es handelt sich um einen bronzezeitlichen Bergbau, der im Revier der hallstattzeitlichen Bergleute angesiedelt ist. Was die räumliche Nähe zwei zeitlich und strukturell so unterschiedlicher Betriebe bedeutet, sollen die Untersuchungen der nächsten Jahre klären.

Im Christian-Tuschwerk wurden bisher fast „nur“ sehr grobe, wahrscheinlich ungefärbte[11] Textilien entdeckt, die von uns als Fragmente von Fördersäcken interpretiert werden.

Der Großteil der textilen Kleiderreste stammt aus den hallstattzeitlichen Abbauhallen, vornehmlich dem Kilb- und Kernverwässerungswerk.

Woher stammen nun die über 200 Textilien? Sie wurden fast alle im so genannten "Heidengebirge" gefunden. Diese einzigartige Gebirgsbildung kommt nur im Salzberg vor und ist bislang nur aus Hallstatt und dem Dürrnberg bei Hallein bekannt. Primär handelt es sich um wieder verfestigten prähistorischen Betriebsabfall. Alles, was an Werkzeugen oder Geräten zu Bruch ging oder nicht mehr benötigt wurde, blieb einfach an Ort und Stelle liegen. Im Lauf der Zeit entstand so ein Bodensatz, der mehrere Meter Höhe erreichen kann[12]. In der Hauptmasse befinden sich in dieser "Dreckschicht" abgebrannte Kienspäne, die zur Beleuchtung in der Grube dienten. Eine weitere sehr große Fundgattung stellen bei der Arbeit gebrochene Pickelstiele dar. Die Sättigung dieser Schicht mit Salz führt zu Erhaltungsbedingungen für organische Materialien, die in unseren Breiten einmalig sind. In diesem Milieu existieren keine Mikroorganismen, die die Fundgegenstände zersetzen könnten. Daher bleiben die weggeworfenen, verlorenen oder vergessenen Geräte und Gegenstände unversehrt, auch jene aus organischem Material, und „warten" auf die Archäologen. Vergleichbare Erhaltungsbedingungen gibt es nur noch im Permafrostboden und in ariden Gebieten.

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[5] Hochstätter 1882: 65-72.

[6] Schauberger 1960.

[7] Hochstätter 1882. – Barth und Neubauer 1991.

[8] Kromer 1959.

[9] Barth 1989.

[10] Barth 1982a: 31-43.

[11] Es liegen bislang keine Farbstoffanalysen dieser Textilgruppe vor.

[12] Barth 1987: 205-224.

Unter „normalen" Bedingungen bleiben für Archäologen in unseren Breiten Textilien nur durch Metallsalze konserviert sowie in Mooren oder unter Wasser erhalten.

Geschichte des prähistorischen Salzabbaues in Hallstatt

Die bisher älteste am Berg nachgewiesene Salzproduktion um 5.000 v. Chr. dürfte sich auf die Nutzung von Quellsole beschränkt haben. Wann man zur bergmännischen Gewinnung des Salzes übergegangen ist, lässt sich zu diesem Zeitpunkt noch nicht sagen.

Der bronzezeitliche Bergbau

Die ersten Spuren eines Bergbaues stammen aus der so genannten Nordgruppe, (Grünerwerk und Appoldwerk) und aus dem Christian-Tuschwerk alter Grubenoffen. Alle drei Fundstellen datieren in das 14. bis 10. Jahrhundert. v. Chr. und stellen die Überreste von großen Schachtbauen dar.

Alle bisherigen Aufschlüsse ergeben folgendes Bild: Die taube Deckschicht aus Lehm, die den Berg in einer Mächtigkeit von 30-70 m überlagert, wird mit einem Schacht durchfahren, bis man im darunter liegenden Haselgebirge auf reines Steinsalz stößt. Dieses Kernsalz wird dann entweder in Abbauhallen flächig ausgebeutet, oder es wird ihm in großen Stollen nachgegangen. Ist eine Lagerstätte erschöpft, wird der Schacht auf der Suche nach neuen Kernsalzbändern weiter abgeteuft. Das Abbaugerät ist ein Bronzepickel mit einem langen Stiel aus Buchen- oder Eichenholz.

Mit diesem Werkzeug wurde hauptsächlich kleinstückiges Salz, so genanntes Hauklein, gebrochen. Außerdem wurde versucht, größere Platten zwischen zwei parallelen Schrämrillen zu brechen oder den natürlichen Verbruch mit langen Brechstangen zu forcieren. Als Betriebsabfall bleiben hauptsächlich Kienspäne und gebrochene Pickelstiele und andere unbrauchbare Geräte auf der Sohle der Stollen und Abbauhallen zurück. Aus diesen Rückständen lassen sich auch die Arbeitsschritte rekonstruieren, die auf das Brechen des Salzes folgten.

Das Hauklein wurde mit Kratzen aus Holz in halbe Kübel, so genannte Schwingen gezogen[13] und mit diesen in spezielle, aus ungegerbter Rinderhaut gefertigte, Tragsäcken[14] gefüllt. Damit wurde das Hauklein zu den Schächten gefördert. Da die Tragevorrichtung der Tragsäcke so konstruiert ist, dass man sie ohne sie abzunehmen entleeren kann, haben wir einen Hinweis auf eine eigene Träger- oder Trägerinnengruppe in der Grube und damit in weiterer Folge ein Indiz für Arbeitsteilung (und kontinuierlichen Arbeitsablauf) im Berg. Beim Schacht angelangt, wurde das Salz vermutlich in große Säcke aus Wolle umgefüllt, die dann mit Hilfe von dicken, aus Lindenbaststreifen geschlagenen Seilen[15] durch den Schacht in die nächste Etage gezogen wurden. Von dort ging es durch den nächsten Schacht weiter nach oben, bis schließlich die Oberfläche erreicht wurde. Über die Verpackung des Haukleins für den weiteren Transport in die Absatzgebiete wissen wir noch nichts. Am ehesten sind aber textile Säcke oder Hautschläuche anzunehmen.

Der Bodensatz besteht im Christian-Tuschwerk fast ausschließlich aus organischen Gegenständen und ist nur mit wenig Salz, Gips und Ton vermischt (Plate 3/A).

Die meisten bekannten Stellen des bronzezeitlichen Bergbaues wurden planmäßig stillgelegt. Über das Ende des Christian-Tuschwerkes lässt sich beim momentanen Forschungsstand noch nichts endgültig sagen.

Auffällig ist, dass aus dem Christian-Tuschwerk trotz der bisher über 50 m langen Grabungsstollen fast nur grobe Textilreste aufgefunden wurden, bei denen es sich um Fragmente von Fördersäcken handeln könnte. Es gibt erst 2 feinere Textilreste, die als Überbleibsel von Kleidungsstücken interpretiert werden könnten. Durch diesen Umstand unterscheidet sich das Christian-Tuschwerk von jüngeren Fundstellen.

Reste von Fördersäcken fanden sich an vielen bisher untersuchten Stellen im Christian von Tuschwerk auch etliche Meter entfernt vom Schacht, wo sie ursprünglich zum Einsatz gekommen sein dürften. Diese Textilien sind nicht als primäre Reste von großen Fördersäcken anzusprechen. Da wir nur kleine Fragmente finden, gehen wir davon aus, dass die Säcke am Ende ihrer Lebenszeit zerrissen und diese Fetzen dann an anderen Stellen in der Grube verwendet wurden. Wir haben bisher aber keinen direkten Hinweis darauf, für welchen Zweck diese Stoffstücke eingesetzt wurden.

Der hallstattzeitliche Bergbau

Im hallstattzeitlichen Bergbau wurde die Produktion grundlegend umgestellt. Der Zugang zur Lagerstätte erfolgte nicht mehr über vertikale Schächte, sondern man erreicht das Kernsalz durch schräge Schürfe. Hatte man das

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[13] Barth 1998: 123-128.

[14] Barth 1992:121-127.

[15] Löcker und Reschreiter 1998: 125-132.

Steinsalz erreicht, begann man, dem Kernstreichen (den Kernsalzschichten entlang) folgend, horizontale Abbauhallen anzulegen. In diesen wird nun nicht mehr kleinstückiges Hauklein, sondern großes Stücksalz produziert. Die gebrochenen Salzplatten sind herzförmig. Die Vorgangsweise kann mit dem Brechen von Mühlsteinen verglichen werden. Man schrämte mit dem Bronzepickel eine tiefe Rille, die den Umriss der gewünschten Salzplatte vorgab und brach anschließend das Innere los. Diese Abbautechnik ist durch den Fund von zwei halben Salzplatten und durch die Negative der bereits abgelösten Platten im Stügerwerk[16] belegt. Wie diese in manchen Fällen weit über 100 kg schweren Salzplatten in weiterer Folge transportiert wurden, ist unklar – eine Verpackung in Stoffsäcken oder Taschen ist auf Grund der Größe und des Gewichtes unwahrscheinlich.

Der beim Schrämen der Rillen anfallende Salzgruß blieb als Produktionsabfall in der Grube zurück. Dadurch entstand ein völlig anderer Bodensatz als im bronzezeitlichen Bergbau. Das so genannte kernige Heidengebirge der Hallstattzeit besteht fast nur aus wiederverfestigtem Salzgruß mit wenigen darin eingebetteten weggeworfenen Gegenständen (Plate 3/B). Auch hier stellen natürlich die abgebrannten Kienspäne die Hauptmasse der Funde dar. Daneben sind wieder viele gebrochene Pickelstiele, abgebrochene Pickelspitzen und Gegenstände des „täglichen Lebens“ in dieser Dreckschicht erhalten geblieben. Scherben von großen Tongefäßen, die Reste großer Feuer und ein Kochlöffel belegen, dass in der Grube gekocht wurde. Durch die gefundenen Exkremente lässt sich auch der Speiseplan der Bergleute rekonstruieren.

Im Gegensatz zum bronzezeitlichen Betrieb haben wir in der Hallstattzeit Hinweise auf die im Berg arbeitenden Menschen. Die Auswertung der Skelette aus dem Gräberfeld[17] deutet an, dass alle am Berg Bestatteten in den Arbeitsprozess eingegliedert waren. Diese These wird durch die im Bergwerk aufgefundenen Schuhe unterstützt. Einige weisen ca. die (heutige) Schuhgröße 30 auf, wurden also von Jugendlichen oder Frauen getragen.

Die Siedlung im Hallstätter Hochtal nimmt durch ihre Lage eine Sonderstellung ein. Gebunden an die Salzlagerstätte liegt der Ort abseits jeder Möglichkeit, Ackerbau oder Viehzucht in einem Ausmaß zu betreiben, das die Eigenversorgung ermöglichen würde. Somit waren die Bergwerksbetreiber auf Versorgung von Außen angewiesen. Auch der Import von Kleidungsstücken und/oder deren Vorstufen ist anzunehmen. Ohne weitere Untersuchungen ist es nicht möglich festzustellen, wo die Fertigung der Textilien stattfand. Bemerkenswert ist, dass die in der Grube gefundenen Wollstoffe in der Mehrzahl die Reste von überdurchschnittlich feinen Textilien darstellen. Hierin scheint sich auch der Reichtum der Gräber wiederzuspiegeln.

Es ist dies ein weiterer Hinweis, dass es in der Grube unterschiedliche Aktivitätszonen gab – und, dass bei manchen Tätigkeiten Textilreste anfielen, die dann auch im Dreck liegen blieben. Welches diese Arbeiten waren, ist bislang unklar.

Auch die in den riesigen Abbauhallen der Hallstattzeit gefundenen Textilien sind als die Reste von „Fetzen“ anzusprechen, die bereits in sekundärer Verwendung in die Grube kamen. Wir gehen nicht davon aus, dass der Verschleiß der „Arbeitskleidung“ für die Anwesenheit von Textilien im Berg verantwortlich ist. Denn zum einen ist es unwahrscheinlich, dass man sich in den großen Hallen häufig (durch Hängenbleiben am Fels oder an spitzen Gegenständen) das Gewand zerriss. Zum anderen schließen wir aus, dass die Arbeitsabläufe im Berg zu einem derartigen Verschleiß der Kleidung führten.

Wir haben bisher keine Hinweise, dass in engen Stollen oder Klüften wie im Kupferbergbau in Salzburg gearbeitet wurde. Auf Grund der Lagerstätte ist dies auch nicht anzunehmen. Auch wenn die Textilien „nur“ die Reste von Fetzen sind, zeigen sie, dass es offensichtlich kein, oder fast kein sehr grobes Gewand in Hallstatt gab, das man hätte zu Fetzen zerreißen können, nachdem es abgetragen war. Es erscheint nicht schlüssig, dass die Arbeit zwar in groben Kleidern verrichtet wurde, jedoch nur die Fetzen des „Festtagskleides“ in die Grube gelangten.

Was den Verwendungszweck dieser Textilreste angeht, haben wir auch aus der Hallstattzeit nur wenige Hinweise. Dadurch dass etliche Stücke in länglicher Form vorliegen und einige noch Knoten aufweisen, können wir sie mit etwas Vorsicht als Bindematerial ansprechen. Für andere Funktionen liegen bisher noch keine Belege vor.

Ähnlich wie im bronzezeitlichen Bergbau lassen sich auch in den großen eisenzeitlichen Hallen unterschiedliche Funktionsbereiche erahnen.

Der überaus erfolgreiche Industriebetrieb der Hallstattzeit dürfte in der Mitte des 4. Jahrhunderts v. Chr. durch eine gigantische Massenbewegung im Hochtal ein abruptes Ende gefunden habe. Große Teile des Tales wurden meterhoch verschüttet und die Stollen vernichtet.

Der Dürrnberg bei Hallein dürfte dann für einige Zeit den Markt beherrscht haben. Der Hallstätter Bergbau erholte sich jedoch nachweislich und produzierte bis in römische Zeit. Die Überreste dieser Produktionsstätten (Westgruppe) sind leider nicht mehr zugänglich.

Im Lauf der Zeit hat der Berg alle Hohlräume wieder geschlossen und die Spuren prähistorischer Aktivitäten gelöscht. Der Salzberg ist ein amorphes Gestein und kann daher durch den Bergdruck wieder „zusammenfließen“. Alleine der Betriebsabfall, der Bodensatz der ursprünglichen Stollen und Abbauhallen, liegt nach wie vor unverändert im Berg eingebettet. Bisher gibt es keine Prospektionsmethoden, um dieses Heidengebirge aufzuspüren.

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[16] Barth 1982b.

[17] Pany 2003.

Daher ist unsere Kenntnis des vorgeschichtlichen Bergbaues auf jene Bereiche beschränkt, wo der neuzeitliche Bergbau zufällig auf diese alten Abbauspuren gestoßen ist.

Auch die beiden Fundpunkte mit den meisten Textilfunden, das Kilb- und das Kernverwässerungswerk, wurden erst durch den modernen Laugwerksbetrieb entdeckt. Besonders zu erwähnen ist in dieser Hinsicht das Kilbwerk. Das Laugwerk wurde Anfang des 18. Jahrhunderts fast zur Gänze im kernigen Heidengebirge angelegt. Das Wasser löste das Salz aus dem prähistorischen Bodensatz und es blieben nur die darin eingebetteten unlöslichen Bestandteile, in der Hauptmasse Kienspäne, sowie auch die Textilien im Schlamm, dem so genannten Werkslaist, auf der Sohle des Werkes liegen. Diese Fundanreicherung wird von uns verlaugtes Heidengebirge genannt (Plate 3/C).
Da die Laugwerke zwischen den einzelnen Laugvorgängen befahren und gesäubert werden mussten, ist es nicht auszuschließen, dass dabei barocke Textilreste und andere Gegenstände ins Werk gelangten und mit den prähistorischen Funden vermischt wurden. Daher können Objekte aus dem verlaugten Heidengebirge erst nach einer naturwissenschaftlichen Datierung oder durch formale Kriterien gesichert als prähistorisch angesprochen werden.
Noch ein weiterer Umstand macht dieses verlaugte Heidengebirge für uns problematisch. Da in diesem „Fundbrei“ auch die abgebrochenen bronzenen Pickelspitzen liegen, und oxidieren, ist momentan noch nicht geklärt, ob der hohe Kupferanteil in einigen der untersuchten Textilproben auf diese Lagerungsbedingungen oder den primären Färbeprozeß zurückzuführen ist.

Das Bergen der Funde

Da der ursprünglich lockere Bodensatz durch den Bergdruck wieder zu „Gestein“ verpresst wurde, ist im Heidengebirge der Presslufthammer das einzige Werkzeug, mit dem Funde geborgen werden können. Diese Vorgangsweise bedingt – im Gegensatz zur Arbeit mit Kelle und Pinsel – dass Funde angeschrämmt werden, bevor sie als solche erkannt und dann freigelegt werden. Daher weisen etliche Textilreste die charakteristischen viereckigen Löcher der Presslufthammermeißelspitze auf. Aufgrund der unterschiedlichen Heidengebirgsarten werden verschiedene Bergungsmethoden angewandt.
Im kernigen Heidengebirge (Kilbwerk, Kernverwässerungswerk, ...) versucht man, mit dem Presslufthammer möglichst große Stücke zu brechen, die an den Tag geliefert und dann unter der Waschanlage aufgelöst werden. Dabei werden die meisten Textilfragmente freigespült. Da jedoch beim Schrämen das kernige Heidengebirge häufig bricht, wo größere Objekte eingelagert sind, werden auch bereits beim Vortrieb Funde freigelegt. Diese werden sorgfältig freigelegt und geborgen.
Im Gegensatz zum kernigen Heidengebirge enthält das Heidengebirge aus der bronzezeitlichen Nordgruppe und dem Tuschwerk fast kein Salz und kann daher auch nicht aufgelöst werden. Die gebrochenen Heidengebirgsstücke werden direkt im Bergwerk nach Funden durchsucht. Wird schon beim Vortrieb ein Textil entdeckt, wird es freigeschrämt und im Block geborgen.

The prehistoric Salt-mines at Hallstatt and its Textile remains

Hallstatt is one of the major „salt-sites“ in the eastern Alps. Its importance is mainly based on the longstanding tradition of salt-mining. Salt production is archaeologically proven around 5.000 before Christ. Intensive mining for rock salt began at the latest in the 14th century B.C (Bronze Age). The Early Iron Age mining activities are archaeologically of special importance. It resulted in extremely precious layers of waste. These miners are buried in the well known cemetery. In the time of Hallstatt salt is being extracted in enormous exploitation galleries. These caverns have been proven to be up to 20 m high and far over 100 m wide. During the mining activities broken tools and salt were simply left on the floor. This layer contains broken shafts, countless spills of spruce and fir used as torches and food remains as well as the textiles that will be studied in the following presentations. The conservation of the organic materials (wool, leather, fur and wool) based on the salt is unique. Because of the excellent preservation it is possible to study the manufacture and the dyeing of the textiles.
155 years ago the first archaeological investigations in the mine already uncovered fragments of prehistoric clothing. Their technical quality caused great excitement. Since 1960 excavations have taken place every year and until now about 200 fragments of textiles have been uncovered. The major part dates to the Early Iron Age. In addition the actual site under study (a Bronze Age mine) yields regularly fragments of woollen textiles, that are thought to be woollen sacks to carry the salt (carrying bags).

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Curriculum vitae

Hans Reschreiter studiert Ur- und Frühgeschichte an der Universität Wien. Seit 1992 am Naturhistorischen Museum tätig. Seit 2000 Grabungsleitung der archäologischen Untersuchungen im Salzbergwerk Hallstatt gemeinsam mit Dr. Fritz Eckart Barth. Arbeitsgebiete sind Holz- und Bastgeräte aus dem Salzbergwerk Hallstatt, prähistorische Keramiktechnologie und Experimentelle Archäologie.

The Textiles from the prehistoric Salt-mines at Hallstatt

Karina Grömer

Abstract

Hallstatt, due to the exellent preservation of fabric structures in the salt-mines, is a very important site for prehistoric textile research. In the course of this work I want to give an overview of the research projects carried out so far and the partly already published results. These are completed with new results, especially from the comparison between Bronze Age and Iron Age finds. Especially in the last years during the excavations in the Bronze Age Christian-Tuschwerk mine many new textile fragments, often with very interesting structures, came to light. The comparison of Bronze- and Iron Age textiles reveal the development of textile techniques during this period and allow some new hypothesis on the interpretation of the salt-mine textiles.

Dem Fundort Hallstatt kommt besonders auch durch die vorzügliche Erhaltung der Textilien aus dem Salzbergwerk ein besonderer Stellenwert für die prähistorische Textilforschung zu. In diesem Rahmen erfolgt zunächst eine überblicksmäßige Darstellung der bisher an den Textilien von Hallstatt durchgeführten und teilweise schon publizierten Forschungen und Ergebnisse. Diese werden ergänzt durch neuere Erkenntnisse insbesondere jene zum Vergleich zwischen den bronze- und hallstattzeitlichen Funden, da in den letzten Jahren durch intensive Grabungstätigkeit im spätbronzezeitlichen Christian-Tuschwerk neue Textilreste mit interessanten Befundungen zum Vorschein kamen.

Introduction

Hallstatt, the eponymous site for the Early Iron Age Hallstatt period (800-400 BC), is a small town situated in the Upper Austrian Salzkammergut. The prehistoric salt-mines and the cemetery are amongst the most important prehistoric monuments of Austria, mainly because of marvelous finds in the rich graves and of the extraordinary good preservation of organic materials such as wood, leather and textiles. These items enable us to have a glimpse of a world 3.000 years ago, something that in this form is hardly possible on any other site in Central Europe.

The chronology of the Hallstatt salt-mines extends according to the ^{14}C data[1] from 1.400 BC to 240 AD, from the Bronze age to the Roman period. There are three main minig districts: First the Bronze Age North Group, second the mainly Hallstatt period East group and finally the late La Tène West Group. They are distinguished not only by the finds but also by the different mining techniques.

The North Group dates after 1.400 BC (Middle Bronze Age/Late Bronze Age (Urnfield Culture) transition), represented by evidence from the (modern) Grünerwerk and Appoldwerk mines. Although geographically the Christian-Tuschwerk mine belongs to the East Group, its finds date to the Late Bronze Age Urnfield Culture (1.260-1.020 BC).

The East Group sites date mainly to the Early Iron Age (Hallstatt period, 800-400 BC), but there are some finds from the Late La Tène period (ca. 200 BC) too. Most of the textile remains originate from the Hallstatt period Kilb- and Kernverwässerungswerk mines. The mining in the East Group is contemporary with the world famous Hallstatt cemetery.

The West Group dates from the La Tène period to Late Roman times (110 BC-240 AD), but only a few finds were made here.

The textile remains were found throughout the prehistoric salt-mines, most of them in the Hallstatt period Eastern Group.

History of scientific research on the Hallstatt salt-mines

Research at Hallstatt has a long tradition and is therefore very heterogeneous. We do not have here a single excavation that covers a particular period of time. The textile remains were found over a period of 150 years under very varied conditions.

The workers in the modern salt-mines frequently discovered ancient objects while mining the salt. One of the earliest known find is the "man from the salt" found in 1734[2]. Usu-

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[1] Compare Stadler 1999.

[2] See F. E. Barth 1989. The body had clothes and shoes on when he was found. He was re-interred in the local churchyard in the year he was discovered.

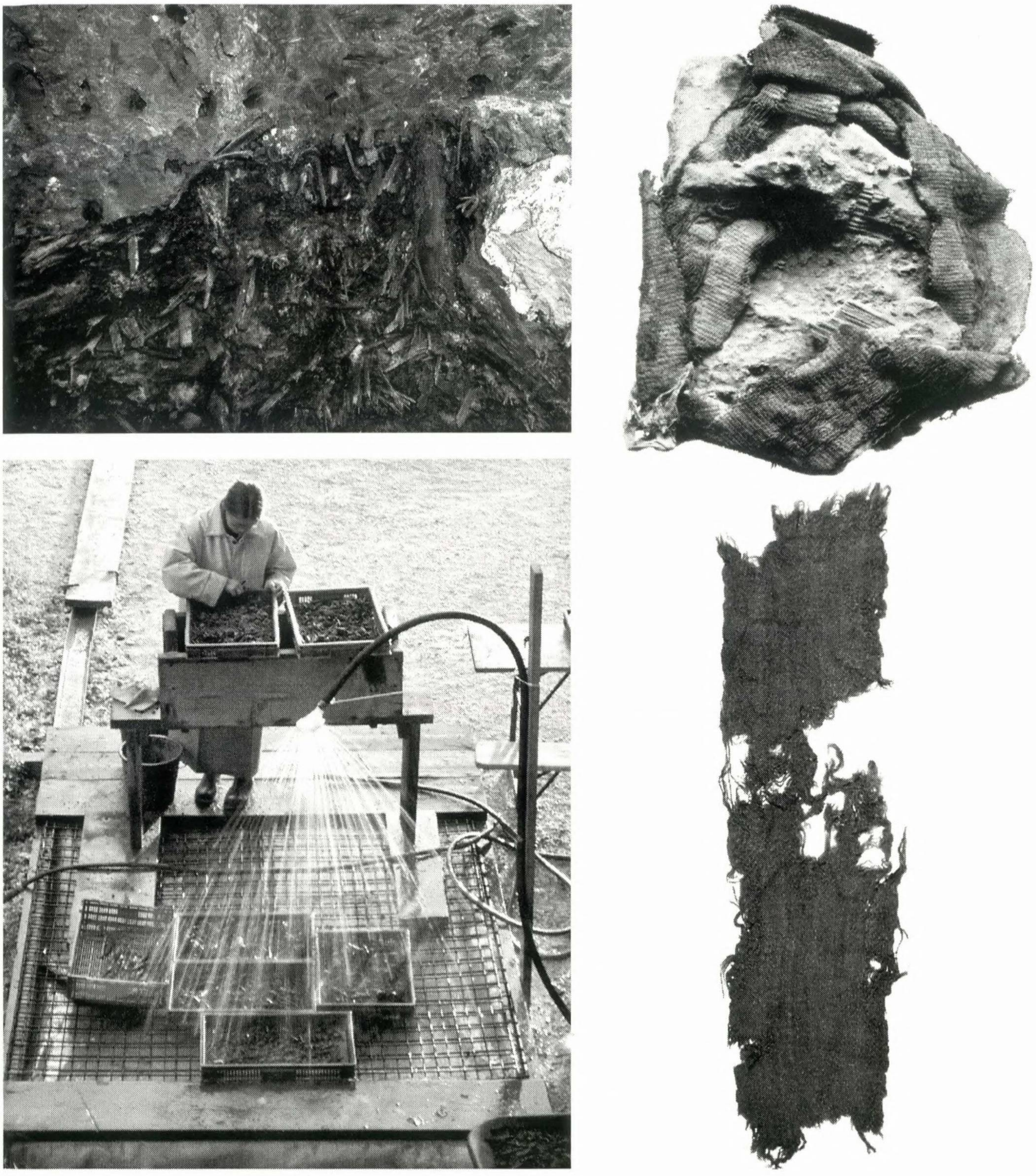

Fig. 1: "Heathen`s rock" in the salt-mines containing traces of early man's presence; washing out the artefacts in water.
Heidengebirge im Salzbergwerk mit prähistorischen Spuren; Auswässern der Funde
(© Naturhistorisches Museum Wien, Prähist. Abteilung).

ally these early finds were not preserved. From 1849 under Johann Georg Ramsauer people started to pay attention to the prehistoric finds, namely the wooden and textile objects. Later, archaeological excavations by the Museum of Natural History in Vienna took place.

In the early years only larger pieces of fabric were kept; during modern excavations even every single thread is documented. Due to the long period of more or less intensive research and a large number of different excavation and conservation techniques the textile finds of Hallstatt are in various states of preservation[3].

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[3] Compare M. Morelli, in this volume.

The first known finds of prehistoric textiles date from 1849; they were illustrated in water colours by Isidor Engl (Plate 4). Important finds were made during the excavations carried out by the Natural History Museum Vienna under Fritz Eckart Barth between 1964 and 1995, especially in the Hallstatt period Kilb- and Kernverwässerungswerk, only few from the Bronze Age Grünerwerk during the campaign 1984-1990. The recent excavations since 1990 under Barth and Hans Reschreiter have been taking place in the Bronze Age Christian-Tuschwerk, Alter Gruben- offen.

The textiles are found embedded in the salt minerals, the so called "heathen`s rock". This means the hard saltstone with traces of early man´s presence (artefacts, wood and so on). During excavation the "heathen`s rock" has to be quarried with pneumatic drill. The artefacts are brought out of the mine with the salt. To actually get the artefacts the quarried material has to be dissolved in water (Fig. 1).
The general state of preservation of the textile remains is excellent in terms of structure and colour compared with textile finds of the same age from other sites.
Beside the approximately 230 textile fragments[4] from the mines we have a few more fragments from the cemetery. They were preserved by corrosion products from bronze and iron objects, mostly Hallstatt daggers and scabbards or La Tène swords.

Unfortunately during the research over more than 150 years some pieces were lost. Numerous finds from the Bronze Age Grünerwerk perished in the chaos during the Second World War. All the textiles, leather and fur objects found during the campaign of 1927 were brought to Halle /Saale for analysis. Their fate is uncertain; probably they were burnt after an air raid.
Another very large piece (1 x 1.4 m) of coarse wool which was found in 1880 in the Appoldwerk was lost before First World War.

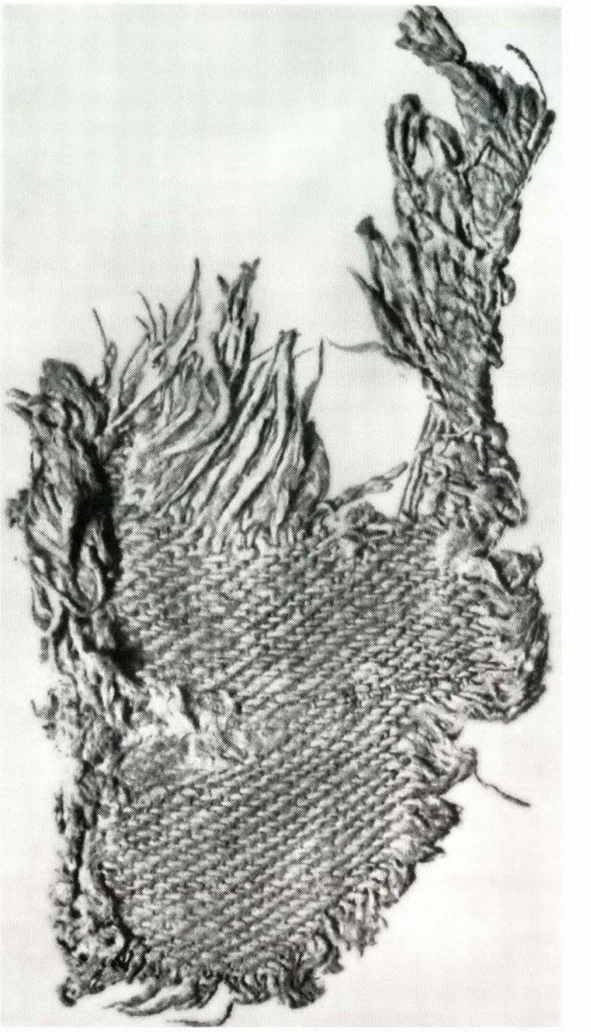
Fig. 2: Grünerwerk, Bronze Age: twill fabric. *Köperbindung* (© Naturhistorisches Museum Wien, Prähist. Abteilung).

So far a lot of research has been carried out on the Hallstatt textiles, especially new investigations since the year 2000. On nearly all textile fragments a fabric analysis has been carried out. Hans-Jürgen Hundt (Römisch-Germanisches Zentralmuseum Mainz) analysed 109 pieces of textile in the years 1959-1987[5]. Katharina v. Kurzynski (Marburg) examined some 90 pieces, on which some of the results were published in her thesis[6]. The author (University Vienna, Institut für Ur- und Frühgeschichte) specialised on tablet-weaving[7] and carried out some experiments including different weaving techniques and also spinning with original spindle whorls. The author cataloged the textiles from the Christian-Tuschwerk. Helga Mautendorfer (University Vienna, Institut für Keltologie) focused on sewing techniques and clothing reconstruction.
Michael Ryder[8](Southampton) analysed the wool fibres of the textiles with regard to their fineness (fibres cross section) and their original colour (percentage of pigmented fibres), while Penelope Walton Rogers[9] (Textile Research Associates, York) carried out spectroscopic dye analysis on 7 textile specimens.
Regina Hofmann-de Keijzer (University of Applied Arts Vienna), Maarten van Bommel (Instituut Collectie Nederland) and Ineke Joosten (Instituut Collectie Nederland) carried out analysis of dyestuffs, mordants and fibres in a first project in 2002-2004. On the base of their results Anna Hartl (Vienna) made experiments with dyes in 2003. The problems of storage, conservation and preservation of

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[4] The approximately 230 textile assemblage (some of them consist of 2 or more pieces) divide into 39 Bronze Age complexes, 136 Hallstatt period complexes and 58 complexes from the Kilbwerk, whose ageing have to be proved.

[5] Hundt 1959, 1960, 1967 and 1987.

[6] Kurzynski 1996. She is working on the Hallstatt period textiles mainly from the Kernverwässerungswerk mine.

[7] Grömer 2001 and Grömer, tablet-woven ribbons, in this volume.

[8] Ryder 2001, with reference to earlier articles.

[9] Walton Rogers 2001.

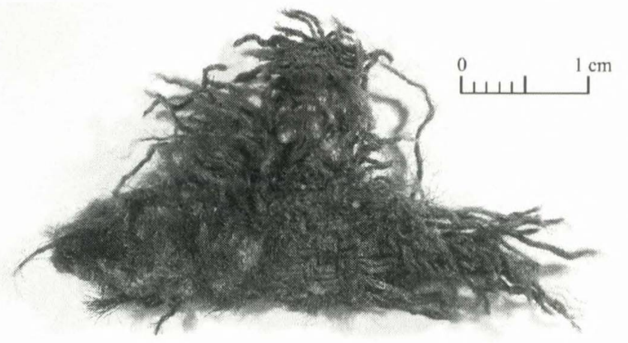

Fig. 3: Christian-Tuschwerk, Late Bronze Age: fine dyed woollen twill fabric.*Feines gefärbtes Wollgewebe in Köperbindung* (© Naturhistorisches Museum Wien, Prähist. Abteilung).

the Hallstatt textiles are the special field of Carine Gengler (University of Applied Arts Vienna, 2003) and Michaela Morelli (Kunsthistorisches Museum Wien, 2004).

Bronze Age mining

The Bronze Age salt-mines date back to 1.400 to 900 BC. Mining in the North Group started in about 1.400 BC. We know textiles from the Appold- and Grünerwerk dating to the transition between the Middle Bronze Age to the Urnfield Culture and from the Christian-Tuschwerk dating to the Late Bronze Age Urnfield Culture (belonging to the East Group). Compared with the Hallstatt period textiles, there is only a small number of finds from the Bronze Age. 14 specimens were found in the Grünerwerk, 20 more complexes (37 individual pieces) in the Christian-Tuschwerk and 2 pieces came from the Appoldwerk (1 is lost). From the Hallstatt period we know of some 140 (confirmed) specimens so far. We expect the number of Bronze Age textiles to increase in the light of the recent and future planned excavations in the late Bronze Age Christian-Tuschwerk.

The only two fabrics made of flax or hemp[10] (Fig. 2) amongst the Hallstatt textiles come from the Bronze Age Grünerwerk; so far as is known, in the Iron Age mines textiles made of wool were used exclusively.

The favourite weave structure was tabby; there are only four specimens made in twill (Fig. 2). Two of these were made from z- spun yarn in flax or hemp. Generally, for the Bronze Age we only know single yarn, but with varying twist (s- or z-spun in different combinations). Plied yarn was not evident in our specimens.

There is evidence for the use of rep starting borders. On some pieces seams are visible; others have a felted surface – obviously they were fulled. We do not have any fabrics with coloured patterns of any kind. The woollen fabrics often incorporate long coarse hair (kemp), especially the less fine specimens like the fragments of carrying bags (hauling bags).

In general the Bronze Age textiles are rather coarse. The yarns were usually 1-1.5 mm in diameter, but we also know of specimens with yarns of 0.3-0.5 mm thread thickness. The thread count lies mostly between 5-10 threads per cm.

We do not know many Brone Age textiles with details of construction like seams or edgings, except some evidences on the carrrying bags (see below).

One very small piece from the Christian-Tuschwerk caught our attention because of its exceptional fineness and its unusual weave pattern (Fig. 3). It is an olive dyed woollen fabric in twill technique with yarns 0.3 mm thick (the yarns were paired in warp and weft). Where the fabric disintegrates it becomes evident that the woven textile was dyed (and not the yarn or the fleece), because the colour did not go completely into the fibres. The thread count is about 16-20 threads per cm, which is very high. On the same fragment a hem is visible.

The carrying bags (*Tragsäcke* or *Fördersäcke*) from the Christian-Tuschwerk

From the Christian-Tuschwerk we have a number of pieces we want to interpret as remains of carrying bags (Fig. 4). They are woven in tabby with a count of 5/5 threads per cm^2. These textiles were all made of very thick threads between 1.5-2 mm diameter in a natural white-brown colour. This still has to be verified through dyestuff analysis, the fibres have to be checked, too. So far as it is preserved, these pieces have a very strong trimming or edging; frequently they used rep for a starting border. Sometimes it is additionally reinforced with another seam, hem or cords. Often the surface of the fragments appears strongly felted; probably they were fulled or milled before use in order to strengthen the texture. Fulled fabrics prove to be far more resistant against mechanical wear; even holes stay confined and do not enlarge.

The Hallstatt period salt-mines

Most of the textile specimens from Hallstatt come from the Early Iron Age mines of the East Group. Especially rich finds were made in the Kernverwässerungswerk und the Kilbwerk. Unfortunately it is not possible to establish their exact age, for radiocarbon dating cannot be used for the centuries 800-400 BC. Hopefully by employment of new dendrochronological dating it will be possible to define an absolute chronology for the Iron Age mines. This would finally enable us to date our textiles more accurately and establish a finer chronology.

The Hallstatt period textiles from the salt-mines display a wide range of different patterns and techniques. We know a large spectre of thread thickness, textures, thread counts, colours, weaving techniques and seams. The most com-

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[10] The fibres of the "carrying bags" from the recent excavations in the Christian-Tuschwerk still have to be classified.

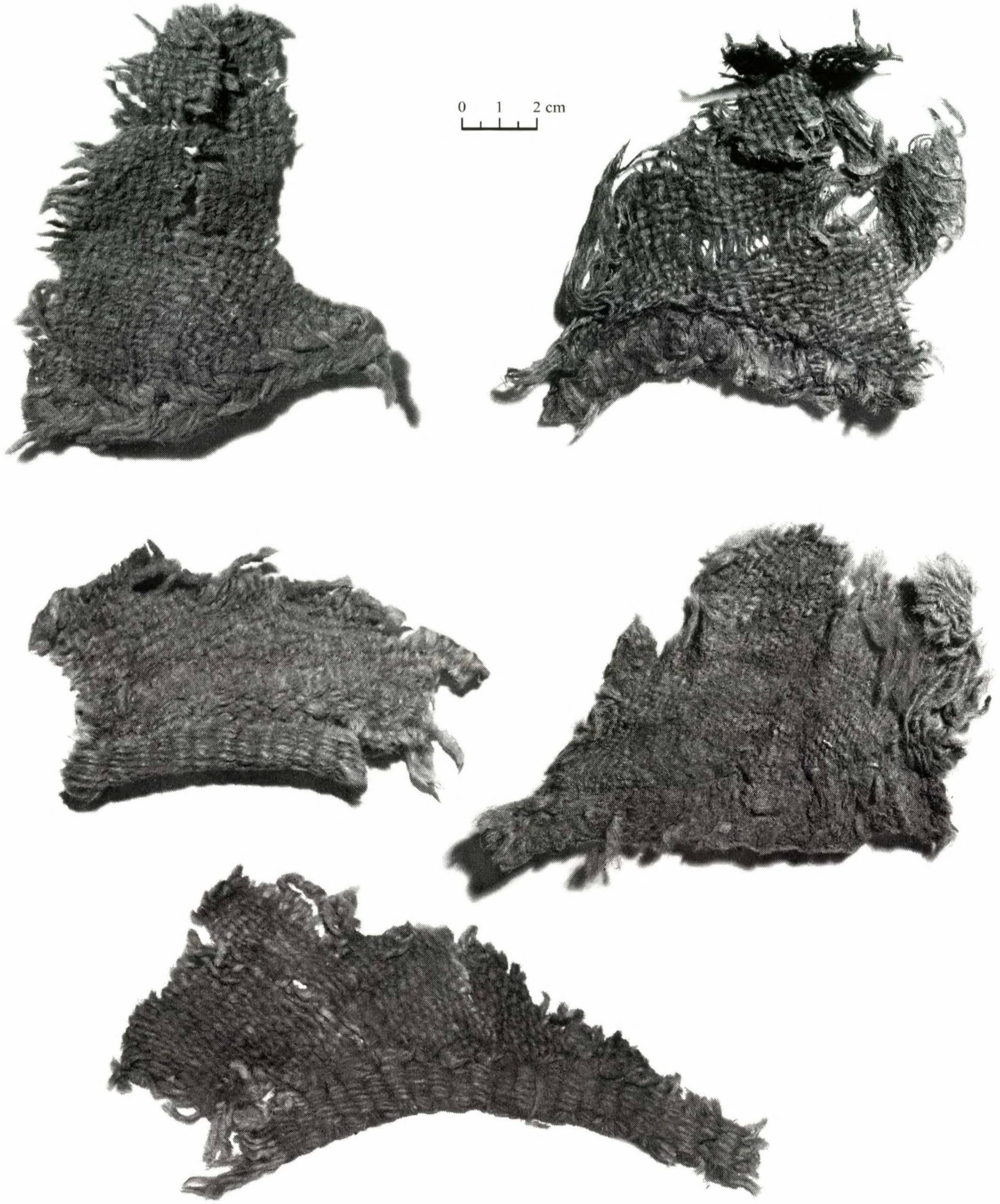

Fig. 4: Christian-Tuschwerk, Late Bronze Age: fragments of "carrying bags". *Fragmente von "Fördersäcken.*
Inv. No. 94.113, 94.849, 91.929, 94.053, 92.020 (© Naturhistorisches Museum Wien, Prähist. Abteilung).

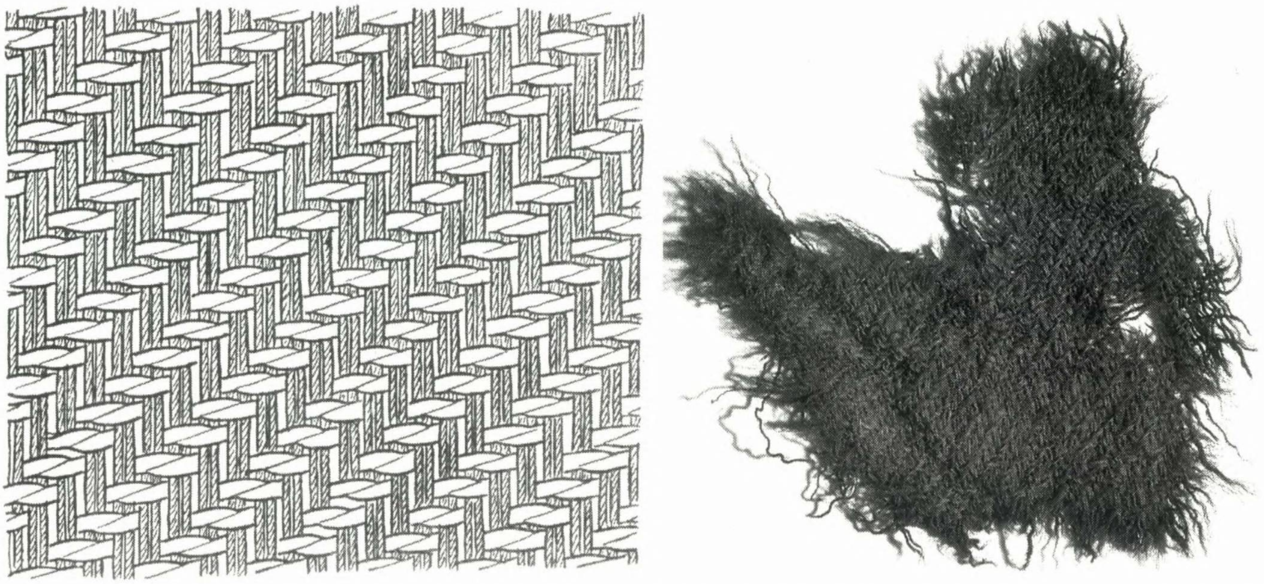

Fig. 5: Hallstatt period salt-mines: twill with warp in plied yarn and weft with paired single yarn. *Köperbindung mit Kette in Zwirn und Schuß mit doppelt genommenem Garn.* Inv.No. 73.337 (based on Hundt 1959, Foto © Naturhist. Mus. Wien).

mon raw material was wool (all of the Hallstatt period woven fabrics, about 140, are made of wool), but we also have two single threads spun from flax or hemp from the Kernverwässerungswerk. One of them is a piece of plied yarn stitched to a woollen fabric. In addition there were found three specimens of fabric made of from horse hair[11]. The horse hair (Fig. 6) was used for weft on rep and tablet woven textiles in order to back up the strength of the fabric to make them more resistant.

Generally the Hallstatt period textiles are very fine and display a very dense texture. Mostly 0.2-0.5 mm thick yarn was used; many specimens have more than 15 threads per cm in warp and weft. Beside these we also know examples of coarse texture (about 1-2 mm thick yarn and a count of 5 threads), sometimes with irregularly spun yarn.

Generally we could observe many different combinations of single and plied yarn, either of s- or z-pattern among the Hallstatt textile specimens. Fabrics with z-spun single yarn in warp and weft were very popular. Some pieces display spin-patterns, created by groupwise change of the direction in which the yarn was twisted. Usually they show alternating groups of s- and z- spun yarn in one system and single z-yarn in the other. Plied yarn was rarely used; it comes only with twill.

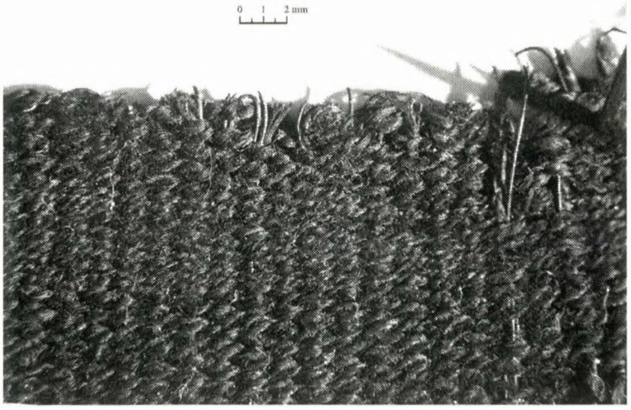

Fig. 6: Hallstatt period salt-mines: ribbon with horse hair as weft. *Band mit Roßhaar als Schuß.* Inv.No. 73.345 (© Naturhistorisches Museum Wien, Prähist. Abteilung).

As in the Bronze Age, here we also have fragments with felted surfaces. If the felting is very irregular or moderate it could well reflect just a pattern of continual wear and use. If a fabric is milled or fulled intentionally, it will be felted and thickened by using water and mechanical stress. Usually we find intentional milling only on textiles of simple weave pattern, such as tabby or simple twill; any more complex structure would lose much of its effect through milling.

Weaves

We documented a lot of different weave structures in the Hallstatt period textiles. Besides the simple patterns like tabby we also have evidence of panama- or basket weave, which is a variant of tabby, employing paired warp and weft threads. There are two fragments where they used only one weft with a double warp. H. J. Hundt[12] called this technique a "*half-basket weave*"; according to the CIETA rules of the Lyon Textile school this fabric is of *Louisine* or *Gros de Tours* pattern[13]. Some basket woven fabrics are very fine employing single yarns of 0.2-0.3 mm in diameter and a count of 30-40 threads per cm.

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[11] Michael Ryder thinks that in one case this maybe could be pig bristles too. Ryder 2001: 223.

[12] Hundt 1987: 270, Abb. 4

[13] CIETA Fig. 25-26.

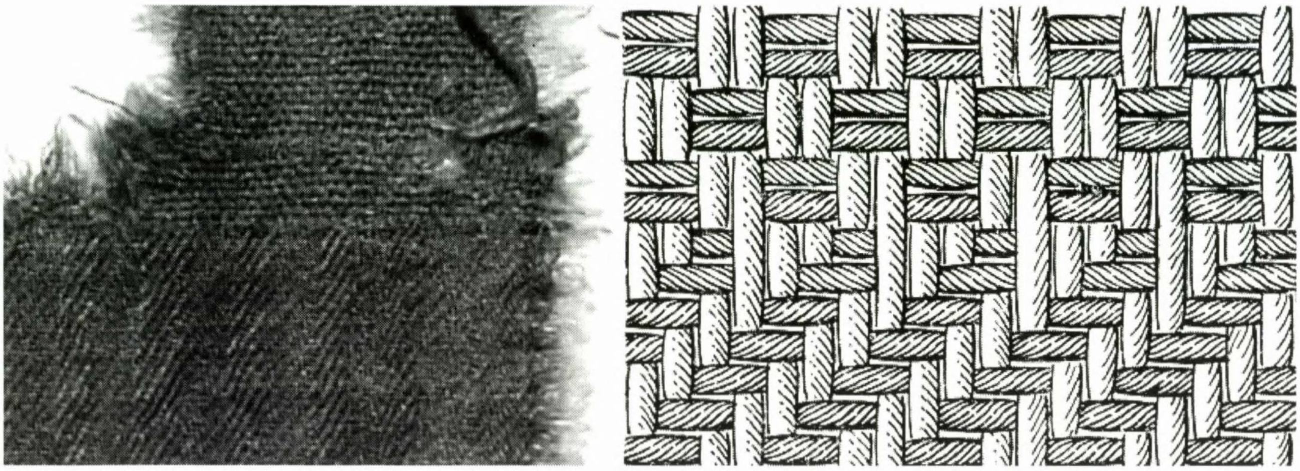

Fig. 7: Fragment Nr. 75.955, transition from basket weave to twill. The fabric displays spin pattern.
Fragment Nr. 75.955, Übergang von Panamabindung zu Köper: Das Gewebe hat ein Spinnrichtungsmuster
(© Naturhistorisches Museum Wien, Prähist. Abteilung. Drawing based on Hundt 1967).

Twill is the most common weave amongst the Hallstatt period textiles. Over 50 % of all textiles show simple diagonal twill. A large varieties of twill techniques could be observed, such as herringbone twill or zig zag twill (Plate 8/3 and 11/3) with alternating stripes of different width and opposing weave directions. Two fragments were made of lozenge (diamond) twill (Plate 5/2).

Most of the twill fabrics consist of single yarn, but plied yarn was also used. A few fragments display warp of plied yarn and weft of paired single yarn (Fig. 5).

One very interesting piece from the Kilbwerk even displays the transition from basket weave to diagonal twill (Fig. 7). It is a very fine fabric consisting of 0.2-0.3 mm diameter yarns and a thread count of 20-30 threads per cm. The fragment displays yet another effect by the spin-patterns employed.

Fabrics in rep technique were used for starting or side borders, as indicated by numerous finds. These were usually produced on a warp weighed loom. In Hallstatt they not only wove ribbons in rep technique, but also quite large ribbed pieces as indicated by some artefacts. Another technique employed in producing ribbons was tablet-weave (Plate 15).

One fragment of olive dyed wool found in the Kernverwässerungswerk sports loops on one side and coloured red ribbon is sewn to one edge (Fig. 8). The side with the loops is heavily felted. We believe the loops and the felting served for insulation. The Bronze Age coat from Trindhoj (Denmark)[14] displays a very similar superficial structure. It also sports projecting loops to achieve a felt-like look. As shown through research by K. Schablow the loops were produced by inserting single wool flocks into the texture. The fabric from Hallstatt evidently has inserted wool flocks too; it does not seem to be a weft-loop fabric. Obviously the Hallstatt fragment was reused for a secondary function; for the looped side faces to the opposite direction from the coloured ribbon (Plate 8/1), which was probably attached later.

Patterns

Nearly half of the Hallstatt period textiles from the salt-mines display patterns of various kinds. The most common are the shadow- or spin-patterns (Fig. 9). They consist of sequenced groups of s- or z-spun yarn which reflect the sunlight differently. Mostly these groups are regular with 6-8 threads of s-yarn and 6-8 threads of z-yarn, but the grouping can be irregular too. This creates the impression of a stripe pattern. Spin patterns were usually employed in one direction (usually the warp), but sometimes in both warp and weft, thereby creating a checkered pattern effect. They can be found on simple tabby as well as on basket weave and twill.

Beside the spin patterns coloured patterns were very common (Plate 5-7). The usual method employed to decorate textiles was to use threads of different dyed colour. For striped textiles (Plate 13/4) which appear very rarely at Hallstatt groups of differently coloured yarns are used in warp or weft, however they are arranged. In Hallstatt stripes are irregular.

Pieces which display the use of different colours in warp and weft for weaving twill, which enhances the pattern effect of the twill (e.g. herringbone twill), are also known from the Hallstatt period salt-mines (Plate 6/4).

Especially favoured amongst the coloured patterns were the checkered designs (Plates 5, 6 and 10). They appear in numerous variations, types and colours. Sometimes the use of different colours in warp and weft is combined with twill variants, such as herringbone twill. The houndstooth design is also present (Plate 6/2-3 and 9/1). It resembles a variation of the checkered patterns. Here we have a regular sequence of colours in warp and weft usually in groups of 4 to 6 threads.

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[14] Broholm and Hald 1940: 27 ff. – Schlabow 1937: 42, Abb. 60.

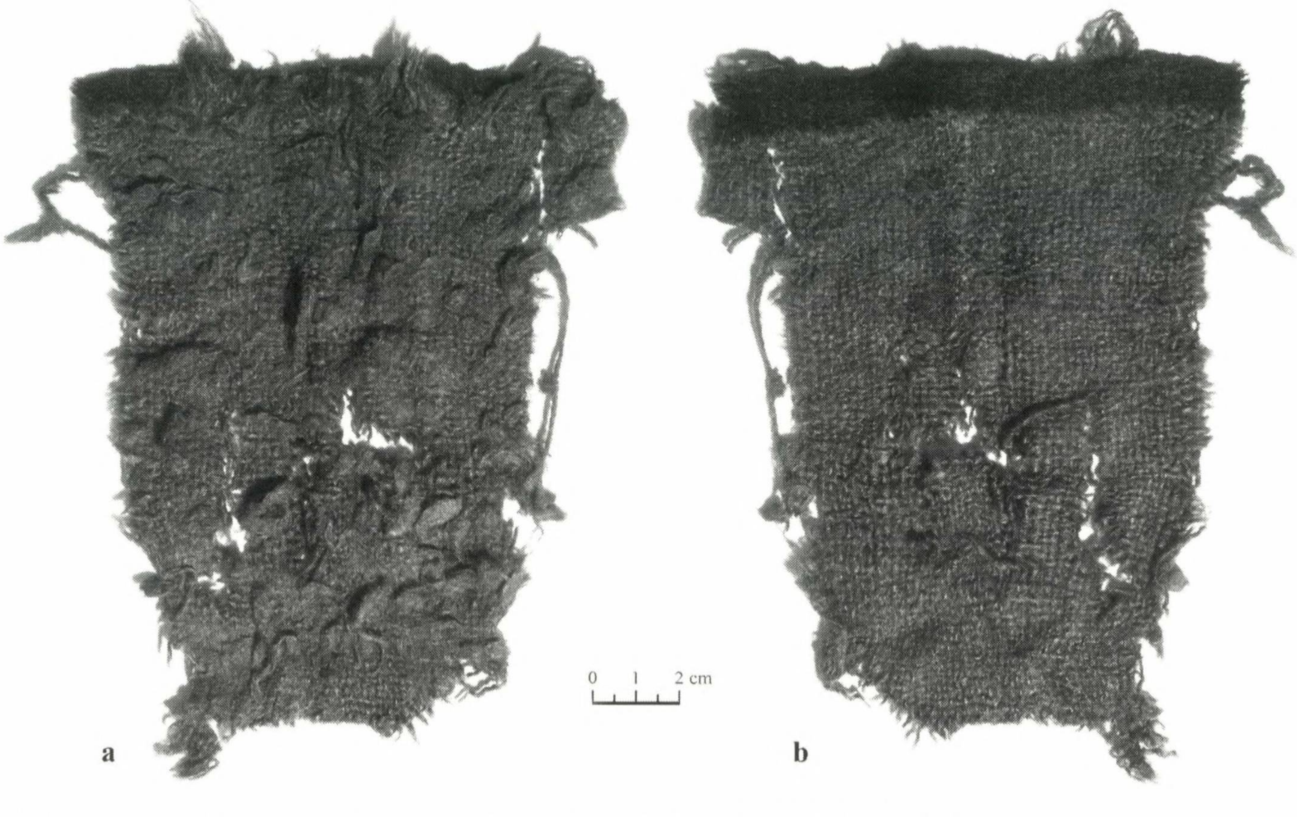

Fig. 8: Textile from the Kernverwässerungswerk with felted surface and loops on one side. *Textilfragment aus dem Kernverwässerungswerk mit verfilzter Oberfläche und Schlaufen auf einer Seite.* Inv. No. 90.067 (© Naturhistorisches Museum Wien, Prähist. Abteilung).

An interesting piece of cloth from the Enderwerk shows marks of repair (Plate 10/1). The prehistoric people had tried to respect its checkered pattern by inserting a small piece of fabric.

Beside the striped and checkered designs figured weavings were also known, especially on narrow rep ribbons and tablet-woven ribbons.

Ribbons

In Hallstatt border reinforcements on textiles were not only woven integrally as starting borders but also seperately produced and attached. These were either woven on special narrow looms or in tablet-weave technique. The ribbons can be monochrome or striped (Plate 7). Three of

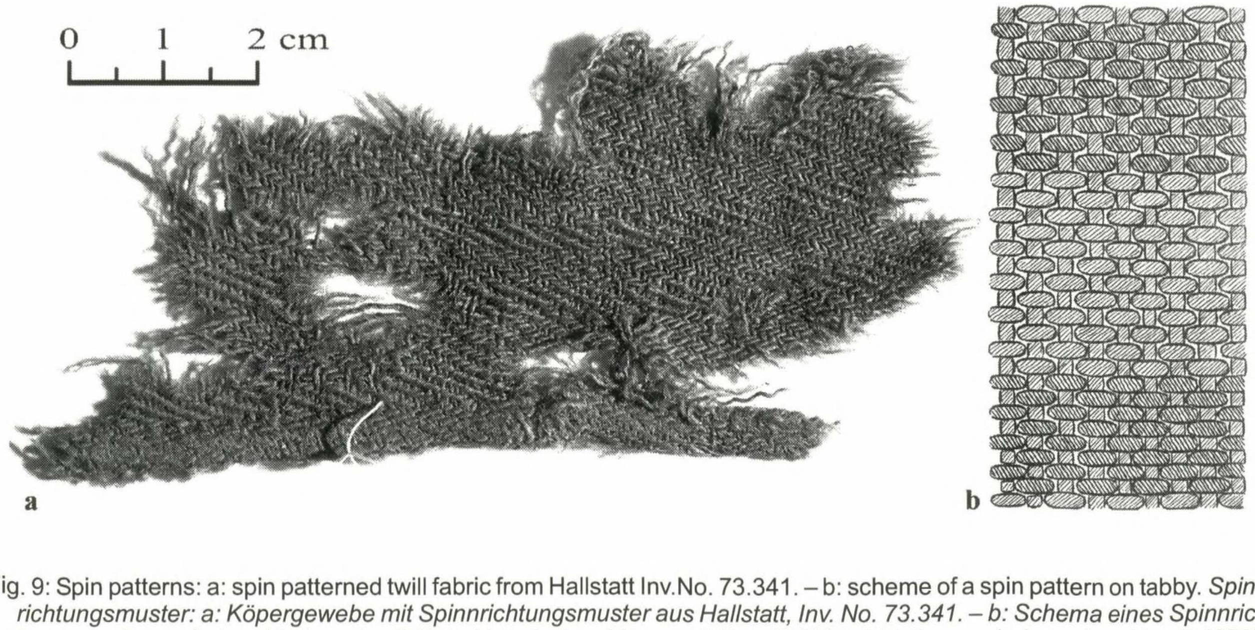

Fig. 9: Spin patterns: a: spin patterned twill fabric from Hallstatt Inv.No. 73.341. – b: scheme of a spin pattern on tabby. *Spinnrichtungsmuster: a: Köpergewebe mit Spinnrichtungsmuster aus Hallstatt, Inv. No. 73.341. – b: Schema eines Spinnrichtungsmuster an Leinenbindung* (a: © Naturhistorisches Museum Wien, Prähist. Abteilung. – b: based on Hundt 1959).

the tablet-woven ribbons display complex multicoloured designs (Plate 15) like filled triangles or meanders. Such multicoloured ribbons were used as decorations and they were also sewn to textiles with starting-borders (Plate 7/1). Ribbons were also produced on a simple tape loom. With this technique a lot of different patterns could be produced such as stripes or checks. The patterns were created by employing coloured yarn only in warp. Because of the ribbed structure of the fabric the weft is not visible and is therefore usually undyed.

Whatever weaving tool was employed, a rigid heddle or a heddle rod loom (Fig. 10), the results achieved are about the same, as experiments showed. Unfortunately we have not found a rigid heddle in Central European Prehistory[15], because all of these weaving tools are usually made of wood. The difficulties lie in identifying weaving tools consisting entirely of wood; for wood is hardly ever preserved on conventional Central European archaeological sites. Secondly, it is hardly possible to identify a simple small wooden rod as a rigid heddle unless it is associated with textile fibres.

For the so-called tape in brocade warp technique ("floating warp") from the Kernverwässerungswerk a special technique on the tape loom was used. The ribbon (Fig. 11, Plate 7/6) is about 4.2 cm wide and some 80 cm long. It displays a brownish red check pattern on a blackish brown background.

The band was woven with a rigid heddle or on a heddle rod loom, but for this special check pattern additional warp threads were necessary. They were inserted into the warp system and were lifted by the use of weft sticks or pattern rods. There may be some different techniques to get a pattern like this, for examplen an other technique to achieve such a pattern is the employment of “flying threads”, but the first way is easier and faster; for the additional threads are fixed in the warp system.

Seams and hems

Numerous Hallstatt period textile fragments display seams and hems in various techniques (Plate 10-11), sometimes two or more fragments were sewn together. These very probably represent remnants of clothing of some kind. Larger pieces were found in the Ender- and Kilbwerk (Plate 9/2-3). Most of the specimen are too small to enable us actually to reconstruct the precise shape of the clothing. Helga Mautendorfer has specialised in the problems of seams, hems and reconstructions, and the present volume contains an article covering her latest results.

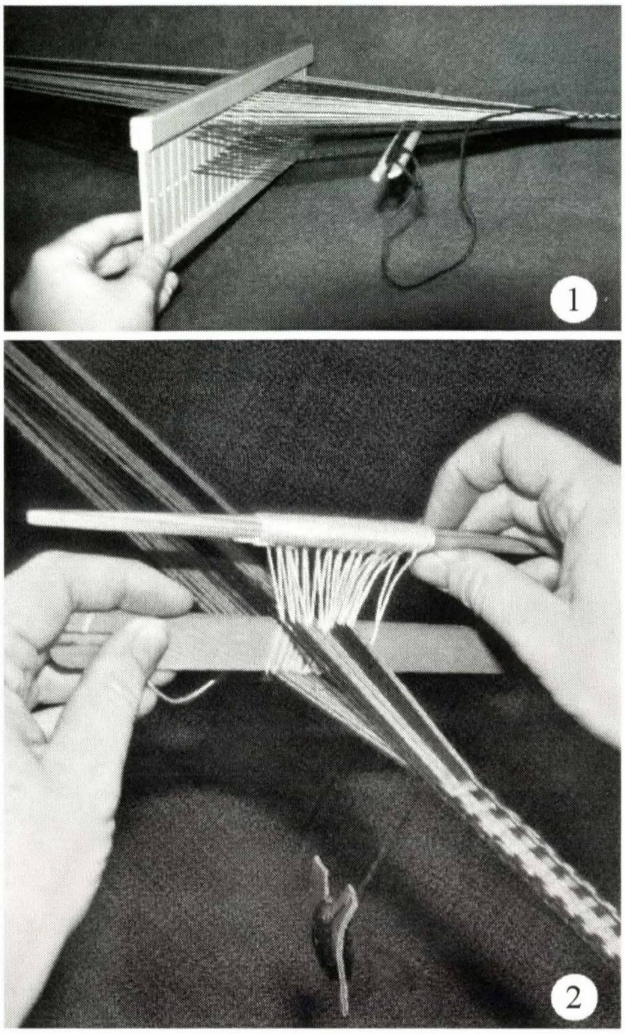

Fig. 10: Simple band (tape) looms: 1: rigid heddle. – 2: heddle rod loom. *Einfache Bandwebgeräte: 1: Webgitter. – 2: Litzenstabweberei* (© P. Grömer).

La Tène period salt-mining

In Hallstatt the mines of the West Group date to the La Tène and the Roman period. The ^{14}C dates are between 110 BC and AD 200[16]. It seems as if the main activities took place during the La Tène period.

There are only a few finds from these mines. Unfortunately they are not accessible to present research due to the danger of collapse in the workings. We do not have any woven fabrics from the LaTène period mines, the only textile find known is a single woollen thread from the Peter-and-Paul-Werk[17]. A few more Late Iron Age textiles from Hallstatt were found in the cemetery where they were preserved by corrosion products on iron artefacts like scabbards.

General overview of threads and colours

Most textiles consist of wool, as mentioned above[18]. Only two woven fabrics of the Bronze Age and two threads

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[15] A part of a Roman Age rigid heddle was found at South Shields, Tyne and Wear. It is made of bone and bronze. Wild 1988: 39, Fig. 27.

[16] Stadler 1999.

[17] Barth 1973: 31 f.

[18] The fibres of the textile finds from the Christian-Tuschwerk still have to be classified.

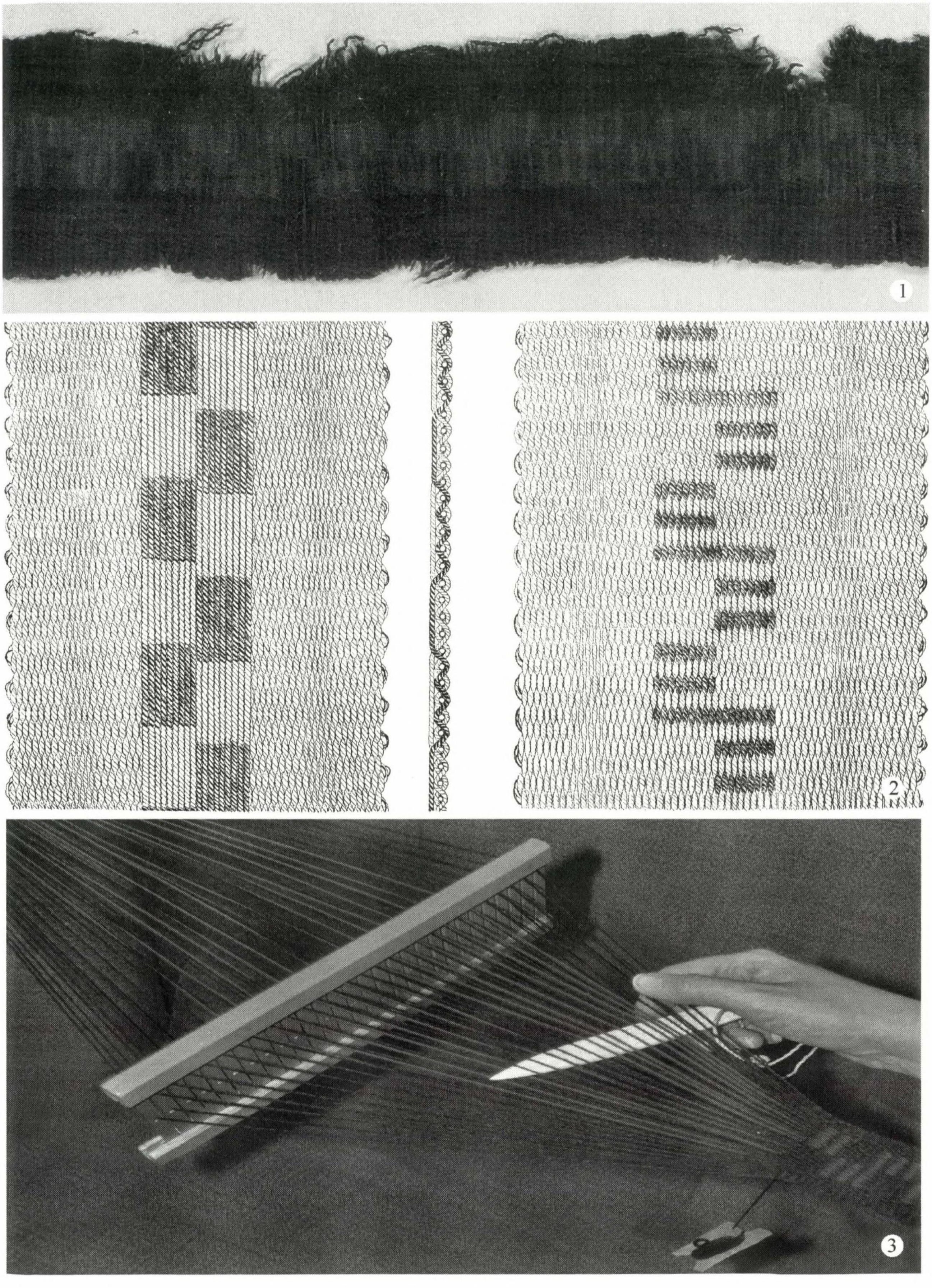

Fig. 11: Band with brocade, Inv.No. 73.345: scheme and experimental reconstruction with a weft stick.
Sogenanntes "Broschiertes Band": Schema und experimentalarchäologische Rekonstruktion mit Eintragsstab
(1: © Naturhistorisches Museum Wien, Prähist. Abteilung. – 2: based on Hundt 1959. – 3: © P. Grömer).

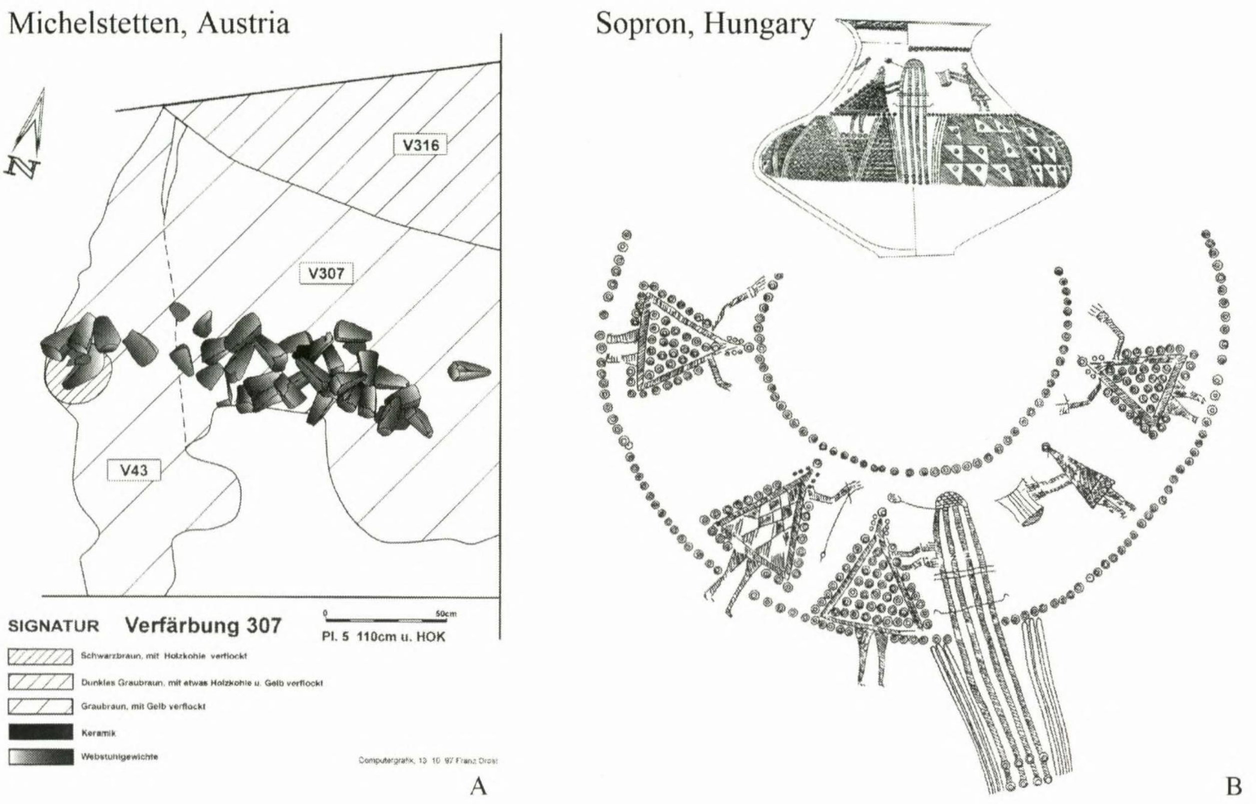
Michelstetten, Austria
N
V316
V307
V43
SIGNATUR Verfärbung 307
0
50cm
Pl. 5 110cm u. HOK
Schwarzbraun, mit Holzkohle verflockt
Dunkles Graubraun, mit etwas Holzkohle u. Gelb verflockt
Graubraun, mit Gelb verflockt
Keramik
Webstuhlgewichte
Computergrafik, 13 10 97 Franz Drost
A
Sopron, Hungary
B

Fig. 12: The warp-weighted loom: A: Archaeological evidence of loom weights at Michelstetten, Lower Austria. – B: Hallstatt period vessel with an illustration of a warp-weighted loom from Sopron, Hungary. *Der Gewichtswebstuhl: A: Archäologischer Befund mit Webstuhlgewichten aus Michelstetten, NÖ. – B: Hallstattzeitliches Kegelhalsgefäß mit Webstuhldarstellung aus Sopron, Ungarn* (A: based on Lauermann 2000. – B: based on Eibner 1986).

from the Hallstatt period were made of flax or hemp. On three fabrics horse hair was used as weft.

Amongst the 315 yarn specimens from the Hallstatt period East Group analysed by Michael Ryder[19] to characterise the wool four main fleece types can be distinguished, 55 % being of hairy medium (primitive hairy) type, 31 % of the more highly developed generalised-medium (primitive woolly) type, another 4 % true medium wool and 10 % semi-fine short wool, both representing "modern" fleece types. Three specimens consisted of true hairy type wool, a type that is believed to have developed through the Iron Age. In addition one specimen (from Ryders` samples) could be identified as spun from plant fibres and another two either from pig bristles or horse hair.

The salt-mine textiles were generally spun from fibre of medium fine quality. The Bronze Age textiles very often have an addition of kemp especially fabrics of poor quality. This addition is rarely found in Hallstatt period coarse textiles, not to mention high quality fabrics. Therefore we know that well-selected wool was used for spinning, especially to get the finest yarns.

One of the questions we are concerned with is the process of textile production beginning with the preparation of the wool for spinning. In the primitive sheep types the finer and coarser wools can be separated if wished by plucking instead of cutting the wool from the sheep[20] (both possibilities can be considered for the Iron Age). However it is possible to spin without any pretreatment; the better the fleece is prepared, the better the results that can be achieved.

There are two primary methods of preparing the raw wool: carding and combing. It is the general view that hand-cards were not used before the Middle Ages[21], but the wool could be picked by hand or beaten to achieve the same fluffy structure as through carding. Spinning a thread with a fleece prepared like that gives the effect of carded yarn. The next essential step for a better preparation is to comb the wool in order to draw the fibres into one direction. A spun thread of parallel fibres is called combed or worsted yarn.

Some of the Hallstatt textiles display structures like spin patterns, which are of such a quality that they are properly

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[19] Michael Ryder measured the wool fibres from a yarn. The fibre diameter can give conclusions about the character of the fleece from which the wool came. His researches do not cover all textiles from Hallstatt, but about half of them. Ryder 2001: 223 ff.

[20] Compare Ryder 1969: 498 ff.

[21] Hand cards (like in folkloristic use) are wooden boards with tiny metal hooks, on which wool fibres can be teased. The first hand cards date to the 14th century. Compare Wild 1988.

		Thread thickness *Fadenstärke*	**m yarn/1g fleece** *m Garn/1g Vlies*
very fine	***sehr fein***	0,2 mm	26 m/g
fine	***fein***	0,4 mm	13 m/g
medium fine	***mittelfein***	0,5 mm	10 m/g
medium fine	***mittelfein***	0,7 mm	7,5 m/g
coarse	***grob***	1 mm	4,5 m/g
very coarse	***sehr grob***	1,5 mm und mehr	2-3 m/g

Fig. 13: Table of thread diameter. *Fadenstärkentabelle* (© K. Grömer).

possible with combed wool; for all the fibres have to lie parallel. On such textiles (spin pattern done with combed yarn) stripes are visible because of the alternation of s- and z-twisted yarns and their different reaction to light. Taking a close look at the Hallstatt textiles it can be recognized that we can find both: threads where the single fibres lie parallel and threads where they do not (those textiles are made of uncombed wool).

It is possible that the Hallstatt weavers knew about the advantages or disadvantages of combed or uncombed wool and could employ these techniques according to demand. Throughout there are differences in softness, thermal efficiency, water absorption and resistance.

Natural wool pigments like white, brown, grey or black were employed as well as artificial dyes like red, blue or yellow. We have examples where either the wool, the yarn or the ready woven fabric were dyed. It is believed that the colours faded or changed during their centuries in the salt, but it is unknown to what degree they were affected. To get an idea, there are currently experiments taking place along with dyestuff analysis. The special problems of dyestuffs on the Hallstatt textiles are the subject of an article from Regina Hofmann-de Keijzer, Maarten van Bommel and Ineke Joosten in the present volume.

Differences between the Bronze Age and Iron Age textiles

The differences between the Bronze Age and Iron Age salt-mines of Hallstatt are evident in many aspects[22], such as the technique of mining and different systems of mine organisation. Moreover, different tools were used for mining as is shown by various artefacts, such as shovels, picks and their wooden shafts, pine-torches for illumination, the leather items, such as bags, shoes or caps, and other tools. But how do the Bronze Age textiles differ from the Iron Age ones?

There are good reasons to presume that the woven fabrics except the ribbons were produced on the warp-weighted loom. This is indicated by the patterns of the starting borders found in Hallstatt and by many finds of looms weights from the Hallstatt Culture and pictoral evidence like on the "urn from Sopron", Hungary[23]. The Hallstatt period vessel from Sopron shows an illustration of a person operating a warp-weighted loom and a person with a hand spindle (Fig. 12B). At Michelstetten, Lower Austria[24], the remains of a warp-weighted loom were found, indicated by 30 weights and postholes in a Hallstatt period rectangular pit. Such archaeological structures are usually interpreted as weaving huts. The loom had a width of about 1.5 m. (Fig. 12A).

It is still possible that besides the warp weighted loom and the band and tablet-weaving looms other tools were employed, like tubular looms, as indicated by textile finds from Denmark[25]. Such a type of loom is hard to identify; for it consists entirely of wooden parts without weights of clay.

To establish the nature of the progress from Bronze Age to Iron Age textile technology at Hallstatt, first some technical differences between the Bronze Age and Iron Age textiles from the salt-mines:

For the Hallstatt textiles a categorization of thread thickness was established (via experiments). This gives some indication of the quality of the piece (Fig. 13): very coarse – coarse – medium – fine – extra fine. The finest yarns found in Hallstatt have a thread diameter of 0.2 mm (this means about 26 m yarn from 1 g fleece). Fine qualities of about 0.4 mm thickness have about 13 m yarn from 1 g fleece. Medium-fine yarns of 0.5 or 0.7 mm correspond to 10 m/g or 7.5 m/g. To make 1 mm thick yarns one needs about 1 g fleece for 4.5 m yarn. Coarse qualities are yarns with 1.5 mm or even greater thread diameter. This is equivalent to about 3.5 m of yarn from 1 g fleece.

In the Bronze Age coarse quality yarns were more widespread especially for the "carrying bags", but they also had yarns of finer quality (Fig. 14). In general the Hallstatt Age yarns are of finer quality, most being less than 0.6 mm in diameter. Coarse yarns of 1 mm or even 1.5 mm thickness are not so common in the Early Iron Age textiles from the salt-mines.

Following the definition of the thread count for pre- and protohistoric textiles by Kurt Schlabow[26] (Fig. 15), coarse fabrics show 1 to 5 threads per cm, medium to normal qua-

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[22] Barth 1982: 33 f., 36 f., Fig. 1, 2 and 5.

[23] After Eibner 1986: Taf. 2.

[24] Lauermann 2000: 20, Fig. 18-19.

[25] Hald 1950: 430 ff.

[26] Schlabow 1974: 186. He counts for his definition of the fabric densities the number of threads on 2 cm in warp and weft.

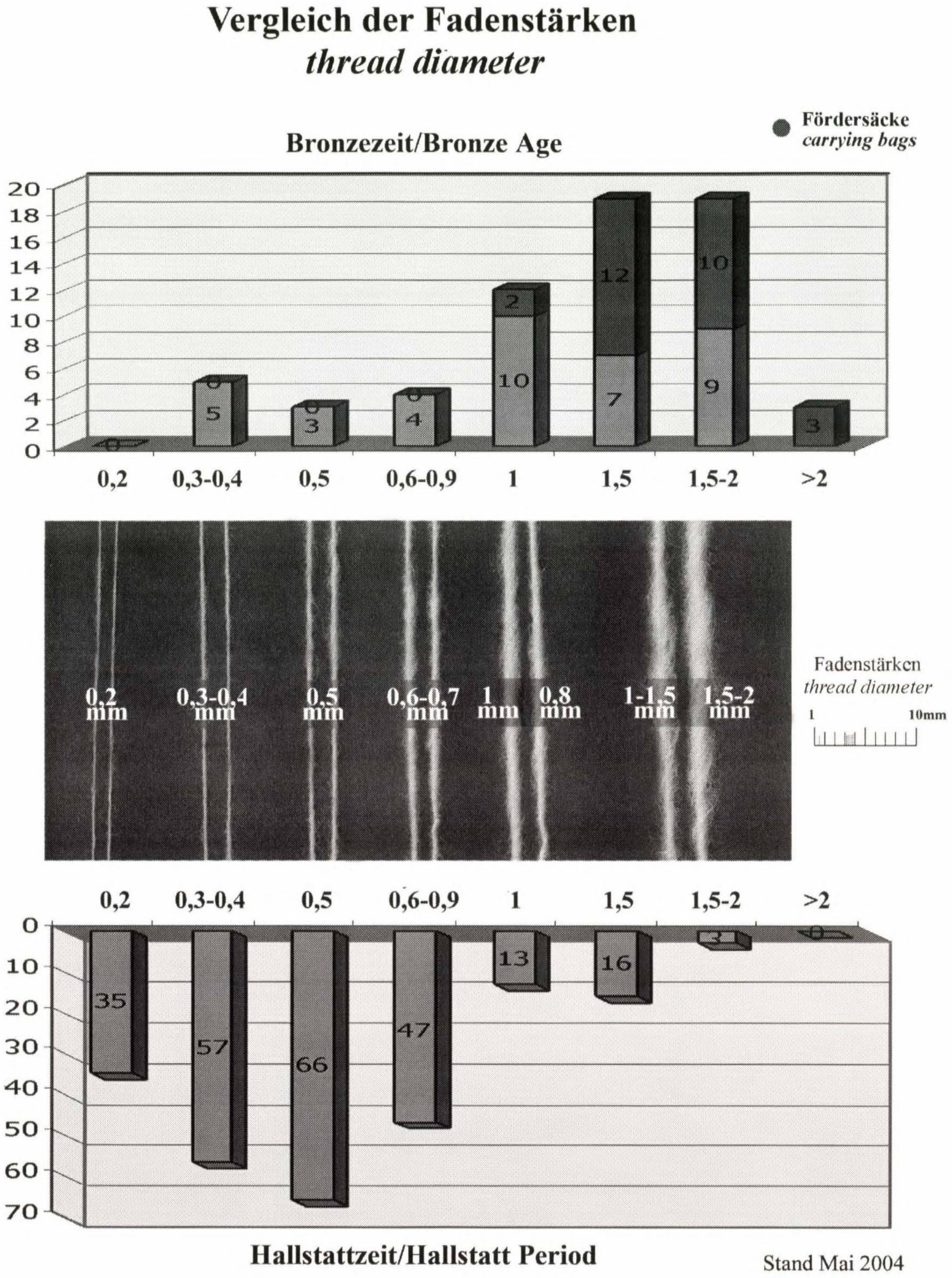

Fig. 14: Comparison of the thread diameter represented in the Bronze Age and Hallstatt period salt-mines. *Vergleich der Fadenstärken zwischen der Bronzezeit und Hallstattzeit in Hallstatt* (© K. Grömer).

lity 6-10 threads per cm, fine quality 11-15 threads per cm, and ver fine quality more than 16.

Most Hallstatt textiles are of fine to ver fine quality, according to the thread count. The Bronze Age woven fabrics are of poorer quality, medium to coarse. We admit that the number of specimens from "carrying bags" from the Christian-Tuschwerk undoubtedly had an influence on this statistic, most of them are coarse with a density of 4-5 threads per cm^2, but none the less a distinct tendency can be recognised.

So far as weave structures (Fig. 16) are concerned, the Hallstatt Age textiles from the salt-mines display far more variants than their Bronze Age counterparts. For the Bronze Age we only have evidence for tabby and simple diagonal twill, but for the Hallstatt period we encounter all the types of weave structure known from Iron Age Europe

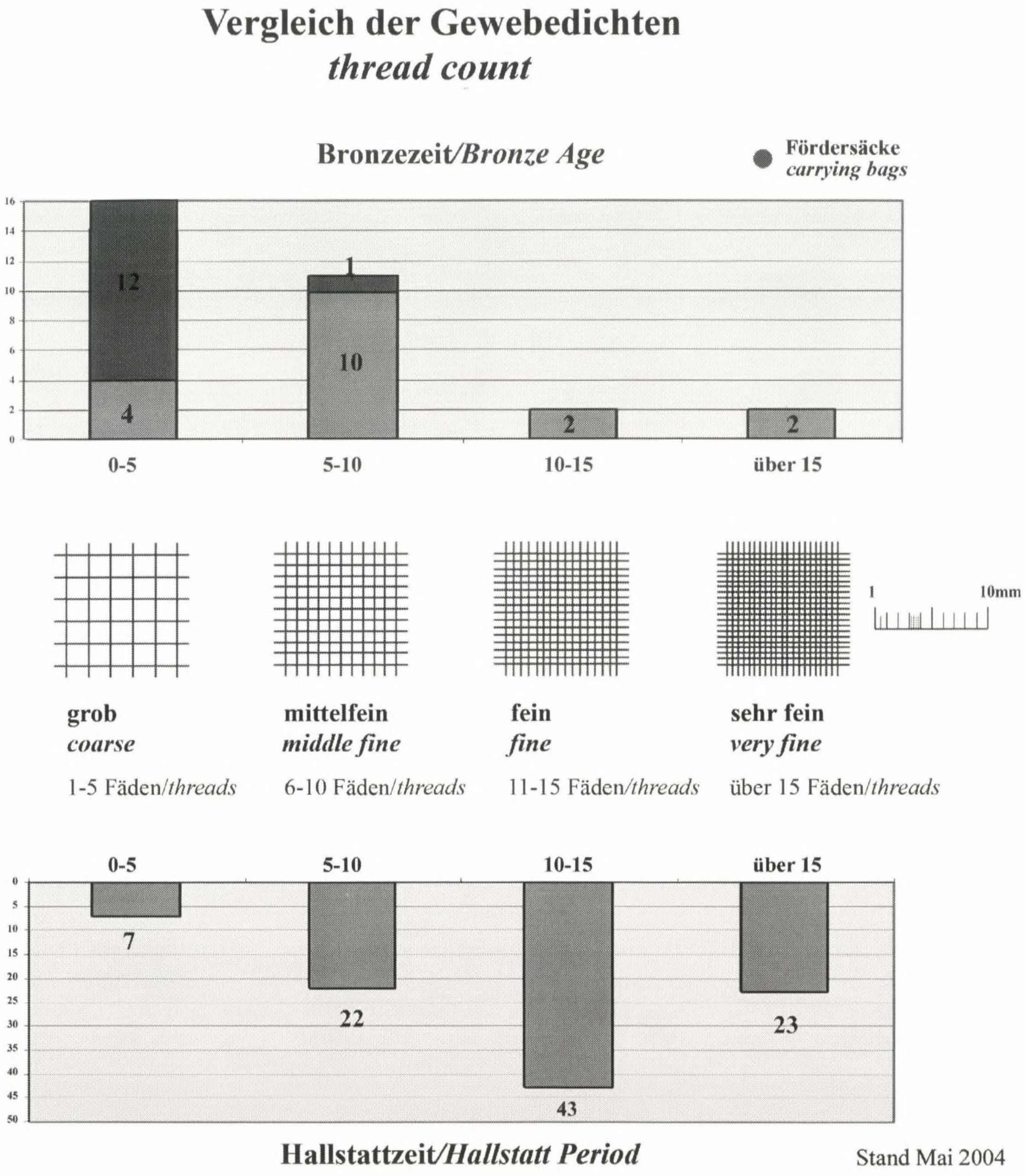

Fig. 15: Comparison of the thread count found in the Bronze Age and Hallstatt period salt-mines.
Vergleich der Gewebedichten zwischen der Bronzezeit und Hallstattzeit in Hallstatt (© K. Grömer).

(tabby, basket weave, diagonal twill, herringbone, zigzag and lozenge (diamond) twill (not in the diagram: half basket weave, rep ribbons and tablet-weave).

Interpretation of the technological differences between the Bronze Age and Hallstatt Textiles

As we have seen there are a number of significant differences between the Bronze Age and Hallstatt period textiles in many aspects. Can the explanation of this phenomenon only be chronological?

It is a well known phenomenon observed all over Europe that Bronze Age textiles and yarns are coarser than Iron Age ones. Rapid technological improvement obviously took place between the Bronze and Iron Ages, as can be seen everywhere in Europe, and it is evident in Hallstatt, too.

For the Bronze Age we know tabby as the common weave at Hallstatt, twill being only rarely used. There are no coloured patterns or spin patterns at this stage. For the Early Iron Age it is very different. Here we see a great variety of patterns, weave structures und sewing techniques. Spin

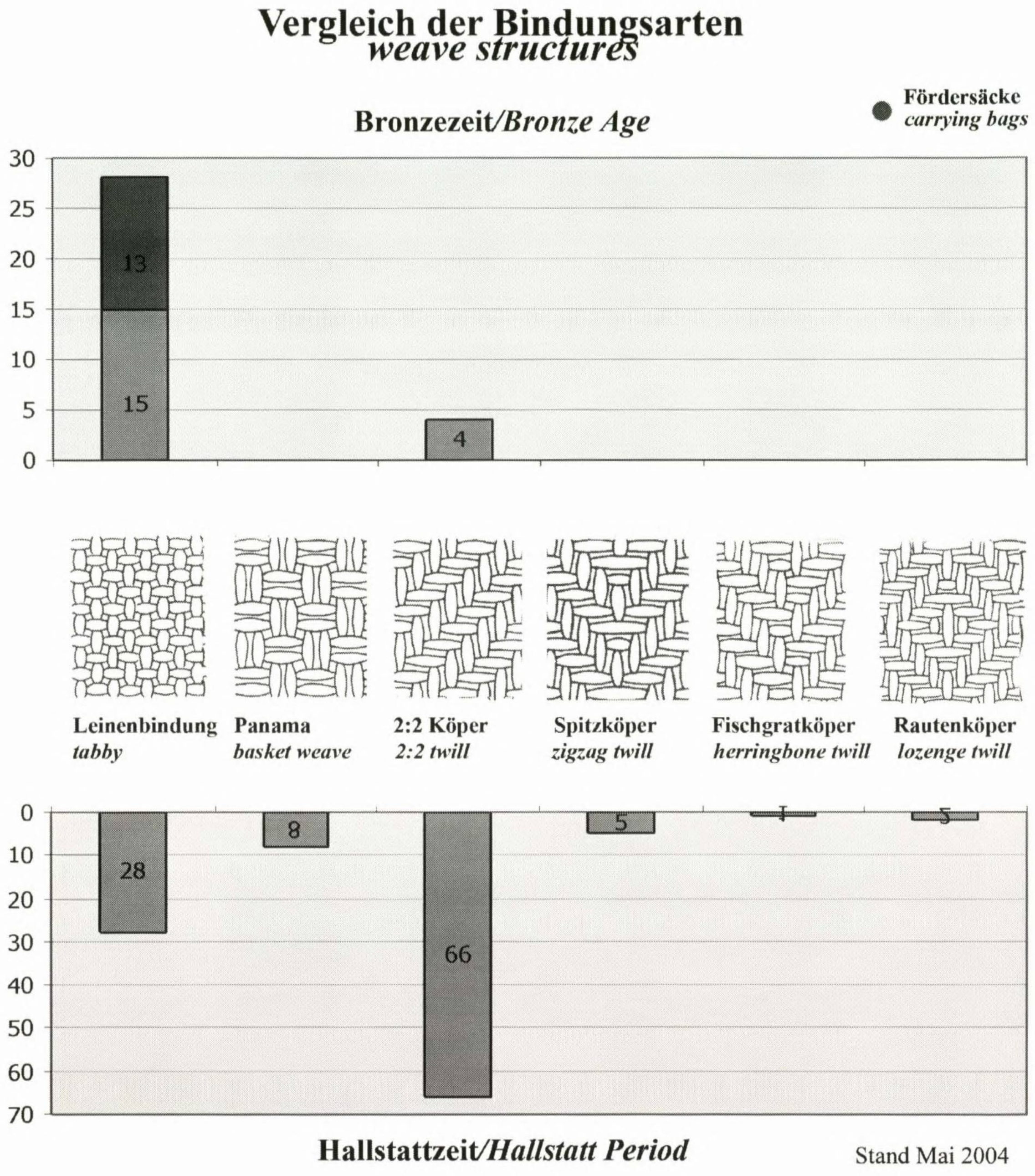

Fig. 16: Comparison of the weaves represented in the Bronze Age and Hallstatt period salt-mines.
Vergleich der Bindungsarten zwischen der Bronzezeit und Hallstattzeit in Hallstatt
(© K. Grömer, drawings of the weaves based on Kurzynski 1996, Abb. 26-27).

patterns become typical for Hallstatt and the Early Iron Age. Generally the fineness of the threads and fabrics increases. In Hallstatt unfortunately it is not yet possible to offer any fine chronology for the Hallstatt period salt-mines.

Another problem is that we usually do not exactly know what function within the mine the places excavated actually had. The recent excavations in the Christian-Tuschwerk show a lot of evidence for functional interpretation of the site. A reason for the great differences between the Bronze Age and the Hallstatt period finds could simply lie in the different functions of their findspots within the specific mining organisation.

The place excavated in the Christian-Tuschwerk is thought to have been a filling station to carry the salt to the surface within the Bronze Age mine[27]. This could explain the overrepresentation of coarse fragments interpreted as carrying bags, as functional tools for the mine-work. They have to be very strong (with thick threads, reinforced rims and fulled surface) because of their intended purpose.

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[27] Reschreiter, in this volume.

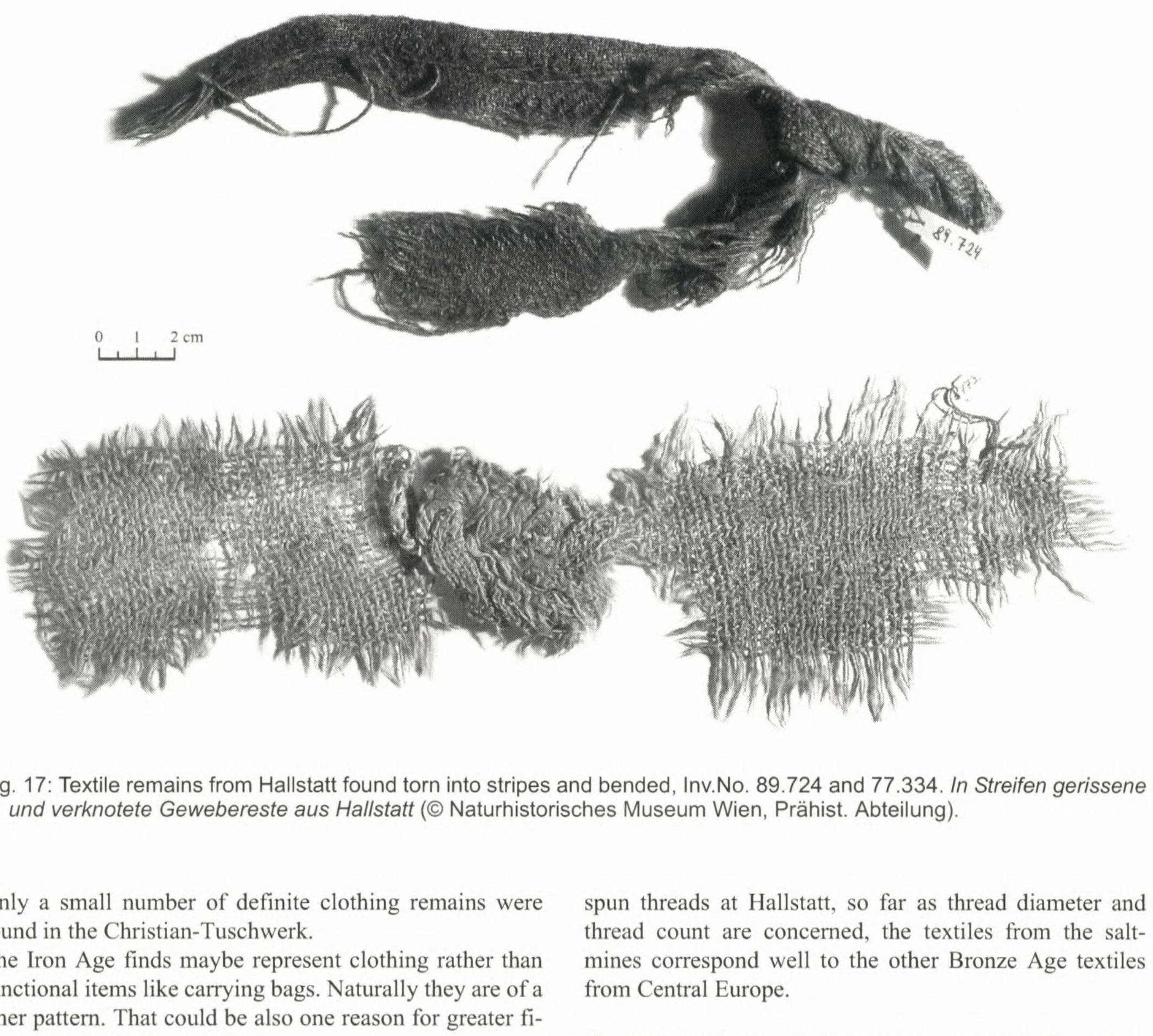

Fig. 17: Textile remains from Hallstatt found torn into stripes and bended, Inv.No. 89.724 and 77.334. *In Streifen gerissene und verknotete Gewebereste aus Hallstatt* (© Naturhistorisches Museum Wien, Prähist. Abteilung).

Only a small number of definite clothing remains were found in the Christian-Tuschwerk.

The Iron Age finds maybe represent clothing rather than functional items like carrying bags. Naturally they are of a finer pattern. That could be also one reason for greater fineness in the Hallstatt period.

Hallstatt and the textile technology of Central Europe

We do not have a great number of Bronze Age textiles from Central Europe so far[28]. Many of them consist of flax, usually with plied yarn. Some of them consist of wool with s-spun single yarns. Tabby is the main technique employed, but twill is also known from the Middle Bronze Age on. For the Bronze Age in Scandinavia, North and Central Germany, woollen textiles are very common. From Hallstatt we do have some flax fabrics, but in them single yarns were used the same way as with the woollen fabrics, which represent the major part of our Bronze Age textiles.

Although there are some different combinations of s- or z-spun threads at Hallstatt, so far as thread diameter and thread count are concerned, the textiles from the saltmines correspond well to the other Bronze Age textiles from Central Europe.

The Hallstatt Culture is divided into an East Hallstatt Province (*Osthallstattkreis*: comprising Austria, Hungary, Czech and Slovenia) and a West Hallstatt Province (*Westhallstattkreis*: comprising South Germany, France and Switzerland). The boundary between these two groups seems to be the site of Hallstatt itself.

The partition of the Hallstatt Culture can also be seen in concern of textile techniques, as has been pointed out by Lise Bender Jørgensen by researching textile finds from graves[29]. Although the definition of some particular types is disputed[30], her researches show very well the differences between East and West in the Hallstatt Culture, which is an important point for the study of the textiles from Hallstatt.

In the Western Hallstatt Province woollen fabrics with plied yarn, sometimes in combination with single yarn weft, are typical. The most common fabric type in this area is the 2/2 diagonal twill Sz/z. Bender Jørgensen called this the Dürrnberg type of fabric, to which about 30 percent of all western farbrics belong.

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[28] Compare Bender Jørgensen 1989: 146 f. – Kurzynski 1996: 24 f.

[29] Bender Jørgensen 1989: 144 ff., compare pie diagrams Fig. 1 and 2.

[30] See the critical advices mainly to the Type Dürrnberg from Kurzynski 1996: 36, Anm. 184.

For the East Hallstatt Province generally single yarn fabrics were the rule. Spin patterned fabrics with 2/2 diagonal twill and single yarns of the Vače type (after Bender Jørgensen) were very popular. These comprise more than 30 percent of all known eastern fabrics.

Although there are remarkable differences between East and West Hallstatt Culture textiles, they still have in common twill and secondly tabby as the basic weave patterns as well as tablet weave. The most common technique is the simple 2/2 diagonal twill, but variants like diamond twill are also known.

Although the site of Hallstatt lies at the boundary of the two great cultural provinces, the Iron Age textiles from Hallstatt are orientated to the Eastern Province. It is unknown whether the textiles were imported or produced locally in the region of Hallstatt.

We do have some spindle whorls from Iron Age graves of the Hallstatt cemetery indicating local production of textiles (Unfortunately we do not have any loom weights from Hallstatt). In our opinion the local production of textiles in Hallstatt was certainly not the main supply for the people living there and maybe was not enough to meet demand, so import was inevitable.

The Hallstatt and La Tène period salt-mines of Dürrnberg near Hallein situated not so far from Hallstatt yielded a large number of textiles[31]. There are great differences between them and the Hallstatt textiles, especially those from the Hallstatt period. While the Early Iron Age samples from Hallstatt are mainly of wool, many of the Dürrnberg fabrics were made of flax or hemp. A further difference lies in the coloured patterns: while there is a great variety of coloured patterns and spin-patterns in Hallstatt, there are only a few from Dürrnberg, mostly stripes, and generally they look much more uniform.

There are also differences in the weaves: in Hallstatt we found mostly twill, usually with single yarns in warp and weft, at Dürrnberg it is tabby with plied yarn, often combined with z-spun yarn.

K.v. Kurzynski[32] saw a possible reason for these differences – aside from chronological factors – in different types of organisation of textile production. In Hallstatt the great variety of patterns, weave techniques, threads and yarns could imply perhaps a decentralised individual household production, while the Dürrnberg textiles, uniformly less complicated fabrics that could be produced fast and with little effort, seem to derive from a centralised workshop, specialising in miners' gear.

The use of the textiles

The textiles from Hallstatt are mostly in a very fragmentary state, for they were extracted with large steamhammers and washed out of the rock. Many pieces were found torn into strips. Obviously this had been done during prehistoric times; some of the strips were found tied together (Fig. 17). Maybe they were used for "technical" purposes, as carrier slings, handle reinforcements or to refix tools.

One piece from Dürrnberg[33] clearly illustrates this fact: a very extraordinary decorated ribbon was found wrapped around a damaged tool handle. This was hardly the intended primary function of the piece.

In the light of the technological evidence and the circumstances of discovery, some of the Bronze Age textiles can be interpreted as functional items for mining, e.g. as "carrying bags", as mentioned above. We would usually except the tools for mining in such a large salt-mine to be standardized, but these carrying bags from the Christian-Tuschwerk are not uniformly made. All of the bag fragments are different: many variants of s- or z- spun yarn in warp and weft or various types of edges are evident. Probably they were manufactured by different producers or even represent different users. But anyway, these carrying bags were definitely not produced in a centralized workshop for the whole salt-mine. Perhaps each family or mining clan had its own style of bag.

Complete garments are not preserved in Hallstatt, but at least there are some easily identifiable fragments. We have a tablet-woven ribbon from the Kernverwässerungswerk (Plate 7/5) that definitely had the function of a sleeve trim. The large piece from the Enderwerk (Plate 9/3), consisting of six patches was definitely part of a garment, although to what part it belonged has to remain uncertain.

Through the great variety of fabrics, coarse and very fine ones, undyed and multicoloured we get some basic idea of the Iron Age art of weave. The seams and hems evident on many of the pieces suggest that they were originally parts of clothing, the original cut of which is anything but easy to recognize.

We have no clear idea exactly which clothes were worn in or outside the mine. But we do know that the population in Hallstatt was quite rich, if we compare the graves with those of the same age elsewhere. And we know from the latest researches on the skeletons from the graveyard from Hallstatt that the people who are buried there worked in the salt-mines[34]. As one possibility we can imagine that the finest textiles in primary use would have been clothes for the people on the surface, later taken in secondary use into the mines, when they were worn out.

In prehistoric societies woven fabrics served different functions. Maybe the textiles of simpler technique was probably used for mining cloth along with leather garments, namely the leather berets, caps and shoes. The coarse textiles maybe belonged to blankets, bags or sacks. We do not know the precise cut of any of the Bronze or Iron Age clothes from Hallstatt so far, but this is an area we are constantly working on.

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[31] Stöllner, in this volume. – Kurzynski 1996: 31 ff.

[32] Kurzynski 1998: 39 ff. – Stöllner, in this volume.

[33] Klose 1926: 346 ff.

[34] Pany 2003.

Most textiles came into the mine as rags in secondary use. Although many of our finds suggest to have been parts of garments, possibly even worn in the mine, this was unlikely to have been their last function. The prehistoric miners certainly did not simply dump their gear just because it was torn; we have plenty of evidence that textiles were repaired ad infinitum (Plate 8/4). We found patched and mended fabrics (Plate 10), which show very clearly, that prehistoric people wore their clothes as long as possible and repaired them very often. One of the reasons for this behaviour is that a lot of time goes into the production of clothes (from spinning and weaving to finishing).

When a piece was considered not to be worth repairing again, it would have been torn into rags and reused for other purposes.

Die Textilien aus dem prähistorischen Salzbergwerk von Hallstatt [35]

Hallstatt ist der namengebende Fundort für die ältere Eisenzeit in Zentraleuropa. Das Salzbergwerk und das Gräberfeld von Hallstatt sind das bedeutendste urgeschichtliche Denkmal Österreichs, unter anderem auch deshalb, weil es durch die Konservierung im Salz gute Erhaltungsbedingungen für organische Materialien gibt; es sind Holzreste, Lederreste, aber auch eine Anzahl von Textilien erhalten. Die Funde ermöglichen einen Blick in die Welt vor über 3.000 Jahren, der in dieser Form bei den meisten archäologischen Fundstellen in Zentraleuropa nicht möglich ist.

Die Gesamtdauer des prähistorischen Bergwerkes in Hallstatt reicht nach den ^{14}C Datierungen von 1.400 BC-240 AD, von der Bronzezeit bis in die römische Kaiserzeit. Es gibt in Hallstatt drei prähistorische Grubenreviere, die sich sowohl in der Abbautechnik als auch in den Funden unterscheiden: die bronzezeitliche Nordgruppe, die großteils hallstattzeitliche Ostgruppe und die spätlatènezeitliche Westgruppe.

Nordgruppe datiert ab 1.400 v. Chr., wobei das Grünerwerk und das Appoldwerk dem Übergang von der Mittel- zur Spätbronzezeit angehören. Das Christian-Tuschwerk, Alter Grubenoffen liegt räumlich in der Ostgruppe, ist aber aufgrund der ^{14}C Datierungen und den Funde in die Spätbronzezeit (Urnenfelderkultur, 1.260-1020 v. Chr.) zu stellen.

Die Fundstellen der Ostgruppe sind großteils hallstattzeitlich (ältere Eisenzeit) (800-400 v. Chr), reichen teilweise bis in die Latènezeit (jüngere Eisenzeit) (200 v. Chr.): der Großteil der Textilreste stammt dabei aus dem hallstattzeitlichen Kilb-, und dem Kernverwässerungswerk. Der Salzbergbau der Ostgruppe ist zeitgleich mit dem berühmten eisenzeitlichen Gräberfeld von Hallstatt.

Die Westgruppe ist latènezeitlich bis spätantik (110 v. Chr.-240 n. Chr.). Von diesem Bereich gibt es nur wenige Funde.

Die Textilien wurden im gesamten prähistorischen Bergbau von Hallstatt gefunden, die meisten jedoch aus der hallstattzeitlichen Ostgruppe.

Forschungsgeschichte

Die Fundgeschichte der Textilien aus Hallstatt ist nicht punktuell, wie etwa bei einem Grabkomplex, bei dem in einer bestimmten Zeitspanne geforscht wird, sondern es kommen seit über 150 Jahren unter den unterschiedlichsten Bedingungen immer wieder Textilen zutage. Früher wurden nur die größeren Exemplare aufgehoben, bei den modernen Ausgrabungen werden auch kleine Fadenreste dokumentiert, inkl. ihrer genauen Herkunft.

Die frühesten Textilien wurden 1849 entdeckt, sie wurden damals auch auf Aquarellen festgehalten (Plate 4). Bedeutende Funde kamen bei den Ausgrabungen des Naturhistorischen Museums Wien unter der Leitung von Fritz Eckart Barth vor allem im hallstattzeitlichen Kilb- und Kernverwässerungswerk in den Jahren 1964-1995 zutage, nur wenige aus dem bronzezeitlichen Grünerwerk von der Kampagne 1984-1990. Die jüngsten Grabungen finden seit 1990 unter der Leitung von F. E. Barth und Hans Reschreiter im spätbronzezeitlichen Christian-Tuschwerk statt.

Die Textilreste aus dem Salzbergwerk von Hallstatt werden im sogenannten Heidengebirge gefunden, kommen dann, soweit sie nicht bereits beim Abbau entdeckt wurden, mit den Salzklumpen aus dem Berg (Abb. 1) und werden ausgewaschen. Sie sind in Struktur und Farbe durch die Salzkonservierung sehr gut erhalten, besser als andere zeitgleiche Textilkomplexe.

Neben den etwa 230 Textilkomplexen aus dem Salzbergwerk[36] gibt es noch einige wenige angerostete Textilfragmente aus dem Gräberfeld von Hallstatt. Sie stammen vor allem von Dolchen und Schwertern aus hallstattzeitlichen und latènezeitlichen Gräbern.

Leider sind bei der mehr als 150-jährigen Auffindungsgeschichte der Textilien aus Hallstatt auch einige Stücke verloren gegangen: Zahlreiche Funde aus dem bronzezeitlichen Grünerwerk sind den Kriegswirren des Zweiten Weltkrieges zum Opfer gefallen. Die Ausbeute der Grabung 1927, Textilien, Fell und Leder, wurde zur wissenschaftlichen Bearbeitung nach Halle a. d. Saale gebracht und ist verschollen. Ein weiteres sehr großes (1x1,4 m) Stück aus grober Schafwolle, gefunden 1880 im Appoldwerk, ist leider vor dem 1. Weltkrieg verloren gegangen. Bisher wurden zu den Textilien aus dem Salzbergwerk von Hallstatt zahlreiche Forschungen durchgeführt: An beinahe allen Textilfragmenten wurde eine Gewebeanalytik durchgeführt. 109 Gewebefunde untersuchte Hans-Jürgen Hundt in den Jahren 1959-1987. Es wurden etwa 90 Stücke (v.a. vom hallstattzeitlichen Kernverwässerungswerk) von Katharina v. Kurzynski aufgenommen. Sie hat in einer Arbeit bereits einige Ergebnisse publiziert. Neben der Aufnahme der bronzezeitlichen Textilien aus dem Christian-Tuschwerk analysierte die Autorin die Brettchenwebereien und führte Nachwebungen der Borten sowie Experimente zum Spinnen mit Originalspinnwirteln durch. Helga Mautendorfer setzt sich mit der Nähtechnik und Kleidungsrekonstruktion auseinander.

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[35] Dies ist die gekürzte deutsche Version des englischen Artikels. Etwaige Anmerkungen zu den einzelnen Kapiteln bitte unter dem englischen Textteil einzusehen.

[36] Die ca. 230 Textilkomplexe aus dem Salzbergwerk teilen sich in 39 bronzezeitliche Komplexe, 136 gesichert hallstattzeitliche Komplexe und 58 Gewebekomplexe aus dem Kilbwerk, letztere müssen noch als prähistorisch verifiziert werden. Diese Textilkomplexe bestehen teilweise aus zwei oder mehreren Einzelgeweben bzw. Fragmenten.

Michael L. Ryder analysierte die Wollfasern der Gewebefunde hinsichtlich ihrer Feinheit und ihrer Eigenfarbe. Im Zuge dieser Untersuchungen wurden an sieben Textilfunden spektroskopische Farbstoffanalysen von Penelope Walton Rogers durchgeführt.

Regina Hofmann-de Keijzer, Maarten R. van Bommel und Ineke Joosten führten 2002-2004 Analysen der Farbstoffe, Beizmittel und Fasern durch. Färbeexperimente auf Wolle zur Herstellung von Rekonstruktionen durch Anna Hartl 2003 sind ein Ergebnis daraus.

Die Probleme der Aufbewahrung, Konservierung und Restaurierung der Hallstatt-Textilien sind das Forschungsgebiet von Carine Gengler und Michaela Morelli.

Bronzezeitlicher Bergbau

Die bronzezeitliche Nordgruppe datiert ab ca. 1.400 v. Chr. Die ältesten Textilreste wurden im Appold- und Grünerwerk geborgen und sind in den Übergang von der Mittelbronzezeit zur Spätbronzezeit zu stellen, sowie aus dem Christian-Tuschwerk, das in die Spätbronzezeit datiert. Aus der Bronzezeit sind insgesamt bisher relativ wenige Textilfunde erhalten, verglichen mit ca. 140 gesicherten Textilien aus der Hallstattzeit. Von den bronzezeitlichen Stücken stammen 14 aus dem Grünerwerk, 20 aus dem Christian-Tuschwerk (37 Einzelstücke, bei 20 Gewebekomplexen), 2 Stücke aus dem Appoldwerk sind verloren gegangen, wie bereits oben erwähnt. Durch die vermehrten Ausgrabungen in den letzten Jahren im Christian-Tuschwerk werden wir aber hoffentlich diese Lücken etwas schließen.

Interessanterweise stammen nach derzeitigem Forschungsstand[37] die einzigen Gewebe aus Flachs/Hanf aus dem bronzezeitlichen Grünerwerk (Fig. 2), während es in den hallstattzeitlichen Bergwerken nach den derzeitigen Forschungen nur Wollgewebe gibt.

Als beliebteste Bindungsart in der Bronzezeit ist die Leinenbindung vertreten, es gibt nur vier Fragmente in 2:2 Köperbindung, von denen zwei aus einfachem z-Garn in Flachs gefertigt sind (Fig. 2). Generell sind nur einfache Garne, keine Zwirne vorhanden, die Garndrehung ist variabel. Gemusterte Textilien sind aus dem bronzezeitlichen Bergbau nicht bekannt.

Es sind für die bronzezeitlichen Textilreste auch Ripskanten als Anfangskanten der Gewebe belegt, einige Stücke tragen Nähte und Säume. Einige Stücke wurden wahrscheinlich gewalkt. Bei den Wollgeweben sind oft Grannenhaare beigemischt, besonders bei den groben Exemplaren.

Allgemein gesehen sind die Textilien aus der Bronzezeit eher grob. Die Fadenstärke beträgt zumeist 1-1,5 mm, es finden sich aber auch Stücke mit nur 0,3-0,5 mm Fadenstärke. Die Dichte beträgt meist 5-10 Fäden pro cm^2.

Ein Exemplar aus dem Christian-Tuschwerk (Fig. 3) fällt aufgrund seiner Feinheit und Bindungsart unter den anderen auf. Es handelt sich um ein olivfarben gefärbtes Wollgewebe in Köperbindung (vielleicht Spitzgrat?) mit 0,3 mm feinem doppelt genommenem z-Garn. Die Farbe ist deutlich sichtbar an den Stellen, wo das Gewebe aufgegangen ist, da es nicht durchgefärbt wurde. Die Gewebedichte ist mit 16 zu 20 Fäden pro cm^2 sehr gross.

Es sind nicht sehr viele größere Teile mit konstruktiven Details wie Nähte oder Säume von der Bronzezeit in Hallstatt vorhanden, das Christian-Tuschwerk erbrachte jedoch einige Reste, die als Fragmente von Fördersäcken interpretiert werden können (Fig. 4). Dieser "Typus Fördersack" wurde aus dicken, 1,5-2 mm starken Fäden in Leinenbindung mit einer Dichte von 5 zu 5 Fäden/cm^2 hergestellt. Derartige Fragmente haben einen starken Rand mit verschiedenen Randabschlüssen. Er wurde oft als Anfangskante in Ripsbindung hergestellt, manchmal verstärkt mit Schnüren und zusätzlichem Saum, Knopflochstich, umnähtem Saum etc. Die Oberfläche ist stark verfilzt. Falls die verfilzte Oberfläche als intentionell und nicht als durch den Gebrauch entstanden zu erklären ist, wurden sie wahrscheinlich gewalkt, um das Gewebe widerstandsfähiger zu machen.

Hallstattzeitlicher Bergbau

Der größte Teil der Textilreste aus dem Salzbergbau stammt aus der älteren Eisenzeit, aus der hallstattzeitlichen Ostgruppe. Besonders fundträchtig sind das Kernverwässerungs- und das Kilbwerk. Es ist bisher nicht möglich, sie näher zu datieren, da auch mit der ^{14}C-Datierung gerade im Intervall 800-400 v. Chr. keine genaueren Daten gegeben werden können. Wir hoffen auf künftige Ergebnisse der Dendrochronologie, damit nähere Aussagen zur konkreten Datierung und vor allem auch zu einer detaillierteren Chronologie der Textilreste getätigt werden können.

Die Textilien der Hallstattzeit sind sehr vielfältig mit einer großen Bandbreite von verschiedenen Fadenstärken, Bindungen, Dichten, Muster, Webtechniken, Säumen und Nähten. Bis auf zwei Flachsfäden aus dem Kernverwässerungswerk sind alle hallstattzeitlichen Textilien aus Wolle gefertigt. Daneben gibt es drei Textilien, bei denen Rosshaar verarbeitet wurde (Fig. 6), in Verwendung als Schussfaden für Brettchen- und Gittergewebe.

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[37] Die Faseranalysen für die neueren Textilien aus dem Christian-Tuschwerk (besonders die sogenannten "Fördersäcke") stehen noch aus.

Insgesamt sind die Gewebe meist sehr fein und dicht mit bis zu 0,2 mm dünnem Garn und Gewebedichten von über 20 Fäden/cm^2. Teilweise sind sie auch gröber, so kommen auch grobe Stücke mit 1-2 mm starkem Garn und Dichten von nur 5 Fäden pro cm^2 vor.

Die verschiedenen Kombinationsmöglichkeiten von Garn und Zwirn sind in Hallstatt vielfältig. Am beliebtesten waren Gewebe aus z-Garn in beiden Fadenrichtungen. Auch der Wechsel von s- und z-Garn in einer Fadenrichtung und z-Garn in der anderen kommt häufig vor. Zwirn ist sehr selten und wurde meist bei Köpergeweben verwendet.

Die Oberflächen einiger Stücke sind zum Teil stark verfilzt, was einen Hinweis auf Walken gibt. Leichte und unregelmäßige Verfilzungen können auch durch den Gebrauch entstehen.

Bei den hallstattzeitlichen Textilien wurden viele verschiedene Bindungsarten dokumentiert: Neben der einfachsten, der Leinwandbindung ist auch eine Abwandlung davon, mit jeweils 2 Schuss- und Kettfäden die Panamabindung bekannt. Es kommt auch eine Bindungsart mit 1 Kett- aber 2 Schussfäden vor, von Hundt mit "Halbpanama" benannt. Besonders die Stücke in Panamabindung sind oft sehr fein mit 0,2-0,3 mm Fadenstärke und Dichten von bis zu 40 Fäden pro cm^2.

Die beliebteste Bindungsart in Hallstatt ist die Köperbindung, darunter am häufigsten der 2:2 Gleichgrat- oder Diagonalköper. Es sind auch Spitz- und Fischgratköper bekannt, sowie aus dem Kernverwässerungswerk auch zwei Exemplare in Rautenköper (Plate 5/2). Obwohl die meisten Köpergewebe mit einfachem Garn gewebt sind, gibt es auch welche, bei denen die Kette aus Zwirn, der Schuss aus doppelt genommenem Garn besteht (Fig. 5). Den eisenzeitlichen Webern oder Weberinnen gelang es auch, während des Webvorganges von der Panamabindung in den 2:2 Köper überzugehen (Abb. 7). Dieses Gewebe bekommt auch noch durch Spinnrichtungsmuster einen zusätzlichen Effekt.

Ripsbindung wurde sowohl bei der Herstellung größerer Gewebestücke verwendet, als auch für Anfangs- und Seitenkanten sowie für separate schmale Bänder. Eine vom Gewichtswebstuhl unabhängige Webart ist die Brettchenweberei, die ebenfalls mit einigen Stücken gefunden wurde (Plate 15).

Aus dem Kernverwässerungswerk stammt ein Fragment aus olivgrüner Wolle mit Schlaufen auf einer Seite (Fig. 8). Es ist an dieser Seite stark verfilzt und es wurde eine Ripsborte angenäht. Es handelt sich anscheinend um einzelne Wollflocken, die als Schlaufen eingesetzt wurden. Schlaufen und Verfilzung wurden wahrscheinlich wegen der Wärmewirkung angebracht. Eine ähnliche Oberflächenstruktur hat der bronzezeitliche Mantel von Trindhoj, Dänemark. Es ist ebenfalls ein Stück mit vielen abstehenden Schlaufen, was ein pelzartiges Aussehen ergibt.

Fast die Hälfte der hallstattzeitlichen Gewebe ist gemustert, wobei Spinnmuster (Fig. 9) die häufigste Mustervariante darstellen. Bei den Spinnmustern wechseln s- und z-Garne in Gruppen ab. Bei Lichteinfall entsteht so durch die verschiedene Reflexion des Lichtes auf unterschiedlich gedrehte Fäden eine Streifenwirkung. Die Spinnmuster wurden sowohl in einer Fadenrichtung, seltener in Kette und Schuss gewebt, letzteres ergibt den Eindruck eines kariertes Musters. Spinnmuster wurden in Hallstatt nicht nur bei einfacher Leinenbindung, sondern auch bei Panama- und Köperbindung verwendet.

Es kommen neben den Spinnmustern auch Musterungen vor, bei denen unterschiedliche Farben in Kette und Schuss eine Rolle spielen (Plate 5-7); so gibt es etwa gestreifte Textilien (Plate 13/4). Eine andere Möglichkeit der Musterbildung ergibt sich dadurch, dass bei Köperbindung die Kette eine andere Farbe als der Schuss hatte (Plate 6/4). Besonders beliebt unter den farbigen Mustern sind aber Karos, die in unterschiedlichen Varianten belegt sind (Plate 5). Auch Hahnentritt (Pepita) kommt vor (Plate 6/2-3 und 9/1), eine Variante des Karomusters, bei dem der streifenweise Farbwechsel bei Kette und Schuss regelmäßig und in sehr kleinen Gruppen von 3-6 Fäden erfolgt. Abgesehen von den einfach herzustellenden gestreiften und karierten Stoffen, sowie farbigen Ripsbändern, kannte man auch schon die Musterwebung, die besonders bei Brettchenweberei angewandt wurde (Plate 7/5).

In Hallstatt gibt es nicht nur Randverstärkungen, die als Anfangskante direkt am Gewebe mitgewebt wurden, sondern es wurden auch schmale Bänder separat hergestellt und dann aufgenäht oder auf andere Weise verwendet. Diese Bänder sind oft mit farbigen Mustern gestaltet (Plate 7). Einige der Bänder sind in Brettchenweberei gefertigt, deren Rekonstruktionen in einem eigenen Artikel in diesem Band vorgestellt werden. Es wurden Gitterwebbänder mit Streifen, Schachbrettmustern gefunden. Die Musterungen wurden durch verschiedenfarbige Kettfäden erzielt. Diese Bänder wurden mit einem Webgitter oder mit Litzenstäben hergestellt, wobei nach Experimenten das Resultat das selbe ist (Fig. 10).

Eine besondere Technik wurde beim sogenannten "broschierten Band" angewandt (Fig. 11). Für die Herstellung dieses Schachbrett-Musters ist ein zusätzlicher Kettfaden nötig, der mit einem Eintragsstäbchen gehoben und gesenkt wird.

An zahlreichen Fragmenten finden sich Nähte und Säume, die in verschiedenen Techniken ausgeführt wurden. Sie legen nahe, dass sie großteils ursprünglich Überreste den Kleidungsstücken waren. Größere Teile fanden sich etwa aus dem Enderwerk und im Kilbwerk (Plate 9).

Latènezeitlicher Bergbau

Die sogenannte Westgruppe datiert nach den ^{14}C Daten um 110 BC-240 AD. Der Großteil ist anscheinend latènezeitlich. In diesen Bergwerken gibt es allgemein nur sehr wenige Funde und sie ist für neue Forschungen bedauerlicherweise nicht mehr zugänglich.

Es gibt aus der Westgruppe keine Gewebereste, aber aus dem Peter- und Paul-Werk der Latène-Zeit ist als einziger textiler Fund ein Wollfaden vorhanden. Daneben gibt es auch in den Latène-Gräbern des Gräberfeldes Hallstatt einige Textilien, die an Metallgegenständen ankorrodiert sind.

Überblick zum Fasermaterial

Der Großteil der Textilien besteht aus Wolle, wie bereits ausgeführt. Nur zwei Gewebe aus der Bronzezeit und zwei Fäden aus der Hallstattzeit sind aus Flachs oder Hanf[38]. Daneben wurden bei drei Bändern als Schußfaden Roßhaar verwendet.

Von der Wolle, die von Michael Ryder mit 315 Garnproben aus der hallstattzeitlichen Ostgruppe untersucht wurden, gibt es in Hallstatt 4 Hauptvliestypen: 55 % sind *hairy-Medium (Primitive hairy)*, 31 % vom höher entwickelten "*Generalised-medium (primitive woolly) type*". Es gibt zwei "moderne" Vliestypen: 4 % echte "*Medium wools*" und 10 % "*Semi-fine (shortwools)*". Drei Garne bestehen aus Wolle vom echten "*Hairy type*", einem Vliestyp von dem angenommen wird, daß er sich während der Eisenzeit entwickelt hat.

Gesamt gesehen sind die Garne der Textilien aus Haaren mittelfeiner Qualität gesponnen. In der Bronzezeit finden sich Beimengungen von Stichel- oder Grannenhaaren sehr häufig, besonders bei groben Geweben. In der Hallstattzeit sind diese seltener, in den feinen Geweben fast gar nicht vorhanden.

Eine interessante Fragestellung ist, wie die Textilien hergestellt wurden, beginnend beim Spinnen der Fäden. Zuerst ist es wesentlich, die auch bei den primitiven Schafrassen der Eisenzeit vorkommenden verschiedenen Wollqualitäten des Vlieses, die feine Wolle und die Grannenhaare zu beachten. Ob die Wolle sorgfältig sortiert wurde oder nicht, beeinflusst später auch das Ergebnis. Bekanntermaßen gibt es weiters zwei primäre Methoden, die Wolle vor dem Spinnen vorzubereiten: Kardieren und Kämmen. Üblicherweise wird behauptet, dass Karden erst ab dem Mittelalter verwendet wurden. Die Wolle kann jedoch auch geschlagen oder mit der Hand gezupft werden, um denselben auflockernden Effekt wie beim Kardieren zu erzielen. Das Vlies kann nun versponnen oder durch kämmen noch besser vorbereitet werden, da beim Kämmen die Fasern gleichgerichtet werden.

Einige der Textilien aus Hallstatt weisen Strukturen auf wie Spinnrichtungsmuster, deren Qualität und Effekt nur mit gekämmter Wolle erzielt werden kann, da bei gekämmter Wolle die Fasern eines Fadens parallel liegen und der Faden dadurch leicht glänzt. Mit einem solchen Garn ist der Effekt des unterschiedlichen Lichteinfalles beim streifenweisen Wechsel von s- und z-Garn gut sichtbar. Bei näherer Betrachtung der Hallstatt-Textilien sind beide Fadenqualitäten sichtbar: Fäden mit parallel liegenden Fasern und solche mit wirr liegenden. Möglicherweise wussten die Hallstattleute von den Vor- und Nachteile von gekämmtem und kardiertem Garn und vielleicht wurden die Textilien auch dementsprechend angefertigt. Diese Untersuchungen befinden sich jedoch erst am Anfang.

Es wurden sowohl die natürlichen Farben der Wolle wie weiß, braun oder grau verwendet, daneben wurden aber auch viele Stücke gefärbt, etwa mit rot, gelb oder blau, wie beispielsweise ein Brettchengewebe mit verschiedenfarbiger Musterung zeigt (Plate 7/5). Es wurden sowohl die Wolle selbst (das Wollvlies und der gesponnene Faden) als auch die Gewebe gefärbt. Wie sehr die Farbe durch die Lagerung im Salz verändert wurde, werden Farbstoffanalysen und Experimente zeigen. Zu den Farbstoffanalysen gibt es einen eigenen Artikel in diesem Band.

Unterschiede der bronzezeitlichen und hallstattzeitlichen Textilien in Hallstatt

Die Unterschiede im bronzezeitlichen und hallstattzeitlichen Bergbau sind auch bei anderen Funden zu sehen, etwa bei den Ledersäcken, Mützen und Kienspänen. Wie unterscheiden sich aber die bronzezeitlichen und hallstattzeitlichen Textilien?

Gesamt gesehen wurden die Gewebe mit Ausnahme der schmalen Bänder wahrscheinlich mit dem Gewichtswebstuhl hergestellt. Hinweise darauf (Fig. 12) geben die Anfangskanten, die bildliche Darstellung eines Webstuhles auf der sogenannten Urne von Sopron (Ungarn), und die Befunde von Webgewichten aus dem Bereich der Hallstattkultur, wie etwa ein Webstuhlbefunde aus Michelstetten, (Niederösterreich) zeigt. Es ist natürlich nicht auszuschließen, dass daneben auch andere Webgeräte verwendet wurden.

Die Unterschiede zwischen den bronzezeitlichen und hallstattzeitlichen Textilfunden aus dem Salzbergwerk werden vorerst technologisch betrachtet.

Es wurde mittels Spinnexperimentenfür Hallstatt eine Einteilung der Fadenstärken geschaffen (Fig. 13-14). Ein Faden von 1,5-2 mm Stärke entspricht in etwa 3,5 m Faden pro 1g Vlies. Bei 1 mm starkem Garn schafft man etwa 4,9 m/g. Die mittleren Fadenstärken wie 0,7 oder 0,5 mm entsprechen 7,5 m/g bzw. ca. 10 m/g. Feinere Qualitäten mit 0,4 mm Stärke sind in etwa bei 13 m/g anzusiedeln. Die feinste in Hallstatt vorkommende Garnstärke, 0,2 mm dünnes Einzelgarn entspricht in etwa 26 m/g Vlies. Wiederum sind in der Bronzezeit eher gröbere Fäden verwendet worden, besonders bei den Fördersäcken aus dem Christian-Tuschwerk. Es gibt aber auch durchaus sehr feine Garne von 0,3 mm. In der Hallstattzeit ist die Fadenfeinheit viel höher. Der Großteil der Fäden hat Stärken von nur 0,5 mm oder darunter.

Nach der Definition von Gewebedichten für prähistorische Textilien von Kurt Schlabow ist grob: 1-5 Fäden/cm^2, mittel bis normal: 6-10; fein 11-15, sehr fein: mehr als 16 Fäden pro cm^2 (Fig. 15). Daher sind ein Großteil der eisenzeitlichen Hallstätter Textilien als fein bis sehr fein zu bezeichnen, die bronzezeitlichen Textilreste sind etwas gröber, mittelfein bis grob. Es muss dabei aber bedacht werden, dass auch hier die groben Fördersäcke aus dem Christian-Tuschwerk das Ergebnis etwas beeinflussen.

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[38] Die neueren Funde aus dem Christian-Tuschwerk müssen erst bestimmt werden.

Bei den Bindungen (Fig. 16) ist in der Hallstattzeit ein viel größerer Variantenreichtum als in der Bronzezeit zu sehen, wo nur Leinenbindung und Gleichgratköper vorkommen. In der älteren Eisenzeit sind in Hallstatt alle zu dieser Zeit gebräuchlichen Bindungsarten zu finden: Leinwandbindung, Panama, Köperbindung mit Varianten inkl. Rautenköper. Dazu gibt es noch Ripsbänder, "Halbpanama" und Brettchenweberei.

Wie sind nun diese Unterschiede zwischen den bronzezeitlichen und hallstattzeitlichen Textilien zu erklären? Ist es ein rein chronologischer Grund oder ist ein anderes Erklärungsmodell auch aufgrund der archäologischen Befundung möglich?

Es ist ein durchaus bekanntes Phänomen, dass die Gewebe der Bronzezeit im Vergleich zur Eisenzeit im Allgemeinen etwas gröber und nicht so dicht sind, sowie nicht so feine Fadenstärken aufweisen. Die Textiltechnologie hat allgemein von der Bronzezeit zur Hallstattzeit rasante Fortschritte gemacht, wie das auch in Hallstatt zu sehen ist. In der Spätbronzezeit gibt es nur wenig Köper-, fast nur Leinenbindung. Es gibt keine Muster in Farbe oder Spinnrichtungsmuster.

In der Hallstattzeit gibt es eine ungeheure Vielfalt an Bindungen und Muster, wobei Spinnrichtungsmuster geradezu typisch für Hallstatt und die ältere Eisenzeit sind. Die Feinheit der Textilien und Fäden nimmt zu, ebenso gibt es unterschiedliche Nähtechniken. Leider ist es noch nicht möglich, innerhalb der hallstattzeitlichen Bergwerke von Hallstatt chronologische Aussagen zu machen.

Betrachtet man die Fundumstände und die archäologischen Befunde – besonders bei den gut dokumentierten Grabungen der letzten Jahre – so ist auch ein weiteres Erklärungsmodell für die Unterschiede der bronzezeitlichen und eisenzeitlichen Textilgruppen anzuführen. An der ergrabenen Stelle im Christian-Tuschwerk war wahrscheinlich ein Füllort, daher können wir die hier gefundenen groben Textilien großteils als Sackreste interpretieren, es finden sich nur wenige Kleidungsreste hier. Auch das kann ein Grund dafür sein, dass die bronzezeitlichen Textilien im statistischen Schnitt viel gröber sind, besonders wenn man bedenkt, dass viele der bronzezeitlichen Textilien zu den Fördersäcken gehören, die natürlich durch den Verwendungszweck schon viel stärker als Kleidung sein mussten. Handelte es sich beim Großteil der hallstattzeitlichen Textilien um ehemalige Kleidung in Sekundärverwendung im Bergwerk, so ist diese schon wahrscheinlich etwas feiner als die Säcke.

Hallstatt und die Textiltechnologie Mitteleuropas

Es gibt aus Mitteleuropa generell nicht viele bronzezeitliche Textilien. Die meisten davon sind aus Flachs, oft aus Zwirn. Einige wenige bestehen aus Wolle und sind aus s-Garn gefertigt. Auch in Hallstatt wurden bronzezeitliche Flachsgewebe gefunden, jedoch sind sie aus Garn hergestellt. Der Großteil der Textilien besteht aus Wolle, in verschiedenen Kombinationen von s- und z- Spinnrichtung. Sie sind jedoch in Fadenstärke und Dichte gut mit anderen bronzezeitlichen Textilkomplexen zu vergleichen.

Beim Vergleich der hallstattzeitlichen Textilien aus dem hallstätter Salzberg mit den von Lise Bender Jørgensen aufgrund von Grabfunden herausgestellten Textiltypen sind auch chorologische Aussagen zu treffen. Wenn auch manche ihrer herausgestellten Typen kritisiert wurden, so ist doch der herausgearbeitete Unterschied zwischen West- und Osthallstattkreis für die Bergwerkstextilien aus Hallstatt interessant. Im Westhallstattkreis (Süddeutschland, Schweiz und Frankreich), sind Wollgewebe mit Zwirn in einer oder beiden Richtungen typisch. Das häufigste Gewebe ist der 2/2 Gleichgratköper Sz/z, benannt von Lise Bender Jørgensen mit Typ Dürrnberg.

Im Osthallstattkreis (Österreich, Ungarn, Tschechien und Slowenien) ist der sogenannte Vače-Typ charakteristisch. Es ist ein Diagonalköper 2/2 mit s- oder z-Garn und Spinnrichtungsmustern.

Im gesamten Hallstattkreis ist der Diagonalköper die beliebteste Gewebeart, danach schließt die Leinenbindung an als zweithäufigstes. Die Grenze zwischen Ost- und Westhallstattkreis ist Hallstatt selbst; die archäologischen Kreise decken sich auch mit den Textilkreisen. Hallstatt orientiert sich bei der Textilproduktion offensichtlich eher am Ostkreis. Ob die Textilien in Hallstatt hergestellt oder aus dem Ostkreis importiert wurden, ist noch nicht mit Sicherheit festzustellen. Wir wissen von den Grabfunden, etwa Spinnwirteln, dass auch in Hallstatt Kleidung hergestellt wurde, aber das war sicher nicht die Haupttätigkeit der lokalen Bevölkerung.

Die in den latènezeitlichen Salzbergwerken von Dürrnberg/Hallein entdeckten Textilien unterscheiden sich stark von denen aus dem ältereisenzeitlichen Bergwerk von Hallstatt. Die hallstätter Textilien sind großteils aus Wolle, am Dürrnberg gibt es auch viele aus Flachs/Hanf. Als Unterschied zu Hallstatt finden sich am Dürrnberg auch weniger gemusterte Textilfragmente, es fehlt die für Hallstatt typische Mustervielfalt, meist sind es einfache Streifen. Die beliebteste Bindungsart in Hallstatt ist Köper, meist mit einfachem Garn gewebt, am Dürrnberg ist es Leinenbindung, Zwirne sind häufiger, oft kombiniert mit z-Garn. Diese Unterschiede werden von Kurzynski einerseits chronologisch erklärt, andererseits auch mit unterschiedlicher Handwerksorganisation. Zum Einen könnte es sich bei Hallstatt um individuelles Haushandwerk handeln, was die große Variationsbreite an unterschiedlichen Mustern, Bindungen und Fadenstärken erklären würde: Am Dürrnberg hingegen ist ein spezialisierteres, zentralisiertes Handwerk möglich, in dem einfacher und schneller herzustellende, weniger komplizierte Gewebe produziert wurden

Verwendung der Textilien

Die Textilien liegen durchwegs nur kleinstückig vor, da sie bereits in prähistorischer Zeit fragmentiert waren und mit dem Schrämhammer aus dem Berg gebrochen und dann aus den Salzgesteinklumpen ausgewaschen werden. Etliche Stücke wurden als Streifen gefunden, dabei wurden offensichtlich in der Hallstattzeit Textilien in Streifen gerissen, teils auch zusammengeknotet (Fig. 17) und in das Bergwerk gebracht. Verwendet wurden sie womöglich für "technische" Zwecke als Tragriemen, "Stiefelfetzen"[39] Fixierung von Werkzeug, Umwicklung der Werkzeugstiele etc. Für Hallstatt haben wir leider noch keinen direkten Hinweis auf derartiges, aber ein Beispiel vom Dürrnberg bei Hallein zeigt dies, da hier ein sehr aufwändiges farbiges Band um einen beschädigten Werkzeugstiel gewickelt war, was sicher nicht die ursprünglich gedachte Funktion des aufwändig gemusterten Bandes war.

Wie bereits mehrfach angesprochen, können einige der bronzezeitlichen Funde aus dem Christian-Tuschwerk aufgrund der technologischen Merkmale und aufgrund der Fundumstände als textile Gebrauchsgegenstände für den Bergbau selbst interpretiert werden, als Fördersäcke. Es handelte sich dabei nicht um einen standardisierten Sacktyp, sondern es können unterschiedliche Fadendrehungen, unterschiedliche Randabschlüsse beobachtet werden.
Diese Varianten bei einem Gebrauchsgegenstand sind vielleicht auf verschiedene Hersteller zurückzuführen, vielleicht auch auf verschiedene Benutzergruppen. Sie wurden wahrscheinlich nicht "zentral" für den Bergbau gefertigt. Die Unterschiede könnten auch feinchronologisch bedingt sein, was aber bisher noch nicht fassbar ist.

Ganze Gewänder sind aus dem Salzbergwerk von Hallstatt leider nicht erhalten. Es gibt jedoch einige gut identifizierbare Kleidungsreste, etwa eine Ärmelborte, ein broschiertes Band, das vielleicht als Gürtel getragen wurde.
Die Nähte und Säume an verschiedenen Textilfragmenten legen nahe, dass die meisten wahrscheinlich ursprünglich Teile von Kleidungsstücken waren, die exakte Formgebung ist jedoch schwer zu ergründen.
Welche der Kleidungsstücke genau im Bergwerk und welche obertägig getragen wurden, ist nicht ganz klar, es gibt jedoch gewisse Denkmodelle: Die sehr feinen Gewebe könnten primär zu Kleidung gehört haben, die vielleicht obertägig verwendet wurde. Die schlichten Wollgewebe wurden wahrscheinlich neben abgetragener Kleidung und Lederbekleidung (Schuhe, Kappen) für die Arbeitskleidung der Bergleute verwendet. Die gröberen Stoffe gehören eher zu Decken, Säcken oder wärmenden Kleidungsstücken. Über konkrete Schnitte der Kleidung können wir leider noch nichts sagen.
Der Großteil der Textilien aus dem Berg wurde offensichtlich als Lumpen und Fetzen dorthin gebracht, als Gebrauchstextilien. Obwohl viele der Textilien wahrscheinlich ehemals Kleidungsstücke waren, stammen die Textilien aus dem Berg anscheinend großteils nicht direkt von der Kleidung der Bergleute. Die prähistorischen Bergleute haben ihre Kleidung wahrscheinlich nicht einfach im Stollen liegenlassen, wenn die Stoffe bei der Arbeit beschädigt oder zerrissen wurden. Einen Hinweis darauf geben die im Salzbergwerk aufgefundenen gestopften und geflickten Gewebe (Plate 8/4 und 10). Sie zeigen, dass die Kleidung so lange wie möglich getragen und immer wieder ausgebessert wurde, weil die Herstellung doch sehr zeitaufwändig war. Also sind sie bis zum letzten Verschleiß getragen worden, danach wahrscheinlich zerrissen und als Putzlappen etc. gebraucht.

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Curriculum vitae

Born in Linz, Austria, 1974, study at the Department for Pre- and Protohistory of the University Vienna (Mag. phil. 1999). Editor of the periodical "*Archäologie Österreichs*" of the Austrian Society for Pre- and Protohistory. Main interests and projects are the Stone Age (Neolithic), Experimental Archaeology, prehistoric textiles. In Experimental Archeology I focused on textile techniques, I presented spinning and tablet-weaving at various events.
Current projects: The Bronze Age textiles from the Christian-Tuschwerk at the salt-mines from Hallstatt, Austria in comparison with the Hallstatt Age fabrics (Dissertation).
– Analysis of artefacts from Hallstatt, experiments and reconstructions of prehistoric textile techniques (spinning, tablet-weaving ...).

Genähtes aus dem prähistorischen Hallstatt

Helga Mautendorfer

Abstract

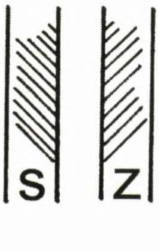
Textilien spielen eine wichtige Rolle im Leben des Menschen. Bedauerlicherweise gibt es nur wenige Anhaltspunkte für das Textilhandwerk in der Urgeschichte. In Mitteleuropa sind prähistorische Textilfunde spärlich. Einer dieser seltenen Funde beinhaltet die bis zu 3.500 Jahre alten Textilien aus Hallstatt. Die rund 230 Gewebe aus dem Salzbergwerk in Hallstatt geben uns Einblicke in das Textilhandwerk und so in das Leben der damaligen Menschen.
Ausgehend von den Sticharten, Nähten und Säumen auf den Hallstatt-Textilien wird im Folgenden der Variantenreichtum des Nähens der Bronze- und frühen Eisenzeit aufgezeigt. Besondere Textilfunde aus Hallstatt werden vorgestellt und unter dem Aspekt des Nähens betrachtet.

Textiles are very important in human society but there are few clues about textile crafts in Prehistory. In central Europe prehistoric textiles are very rare. One of these uncommon discoveries are the 3.500 year old textiles from Hallstatt. About 230 textile samples from the salt-mines tell us stories about the intricate crafts and the life of prehistoric man. The Bronze Age and Iron Age textiles feature a wide variety of differences in textures, patterns and colours. The textiles reveal the sewing techniques used. Samples with hems, seams, reedings, and patches with varied stitches are common.
Starting from the stitches, seams and hems on Hallstatt textiles I will discuss the varieties of sewing-techniques in the Bronze and the Early Iron Age. Some extraordinary finds will be considered under the heading of sewing. Details, like round hems, slantwise seams and added fabric patches point to more complex clothing patterns and give us some new notions of clothing in prehistoric times.

Einleitung

Obwohl Textilien eine sehr wesentliche Rolle im Leben des Menschen spielen, gibt es aufgrund der klimatischen Verhältnisse leider nur spärliche Hinweise auf das Textilhandwerk in der europäischen Urgeschichte. Die organischen Materialien vergehen im Boden und es bleiben nur wenige Zeugnisse von den textilen Produkten übrig, daher sind in Mitteleuropa prähistorische Textilfunde selten. Eine dieser raren Funde wurden im Salzbergwerk von Hallstatt gemacht mit bis zu 3.500 Jahre alten Textilien. Bisher wurden mehr als 230 Textilreste gefunden, die uns Einblicke in das Textilhandwerk und so in das Leben der damaligen Menschen geben. Die bronze-, urnenfelder- und hallstattzeitlichen Textilien weisen ein breites Spektrum an Feinheiten, Bindungsarten, Mustern und Farben auf. Weiters geben uns die Textilien durch die verschiedenen Säume, Nähte, Ziernähte und Flickungen Auskunft über Nähtechniken. Über 70 Textilfunde aus dem Hallstätter Salzberg weisen genähte Details auf.
Das Nähen spielt in der Urgeschichte eine wichtige Rolle. Schon seit dem Beginn der Verwendung von Kleidung im Paläolithikum[1] werden Stoff-, Leder- oder Fellteile mit Nadel und Faden zusammengenäht. Doch das Nähen diente nicht nur dazu, Stoffteile zu verbinden und Kanten zu versäumen, auch die Verzierungsfunktion wie bei Ziernähten und der Stickerei ist ein wichtiger Aufgabenbereich des Nähens. Das Annähen von Borten[2] und anderen dekorativen Elementen wie Bronzeknöpfchen[3] oder Zierblechen gehört ebenfalls zu den Aufgaben der/des Nähenden. Weiters spielte auch das Reparieren von Kleidungsstücken, das Stopfen und Flicken[4], eine nicht geringe Rolle im Bereich der Nähtechnik.
Das Nähen sollte als Verbindungsglied zwischen der textilen Fläche und dem getragenen Kleidungsstück betrachtet werden, und gerade aus diesem Grund ist es ein wesentli-

Fig. 1: Fadendrehung: S- und Z-Richtung (© H. Mautendorfer).



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[1] Vgl. Stradal und Brommer: 7-8. – Wild 1988: 33.

[2] Vgl. Grömer 2001: 49-50.

[3] Vgl. Pertlwieser 1987: 64.

[4] Vgl. Hundt 1960: 149, ein geflicktes Gewebe aus Hallstatt.

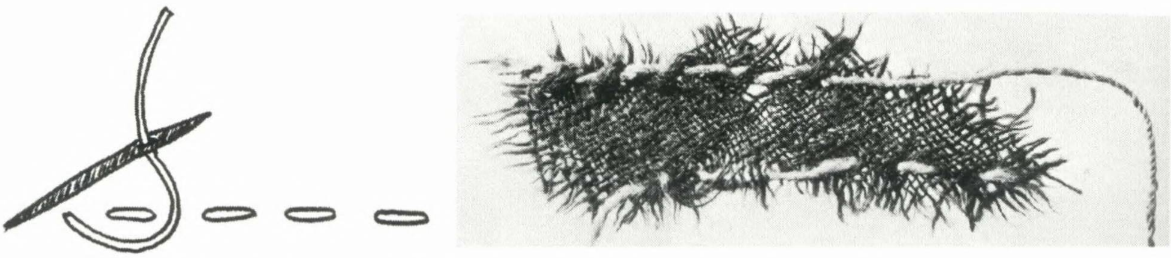

Fig. 2: Vorstich – *running stitch* (Zeichnung: © H. Mautendorfer. Photo: nach Hundt 1967).

cher Bestandteil der Textilverarbeitung. So haben vor allem Nähte einiges zu erzählen, sie führen zu Erkenntnissen im technischen, handwerklichen Bereich und können uns gleichzeitig etwas über die Trageweise und das Aussehen der Gewänder verraten.

Grundsätzlich versteht man unter Nähen das Verbinden von unter anderem textilen Flächen mittels Nadel und Faden. Bei Genähtem können verschiedene Naht- und Sticharten unterschieden werden. Wichtige Details sind hier die Drehrichtung (Fig. 1), Farbe und Stärke des Nähfadens, der Stichabstand und die Stichlänge.

Die Sticharten

Der Schlingstich

Der in Hallstatt am häufigsten vorkommende Stich ist der Schling-, Schnur- oder Wickelstich (Fig. 3). Die Anwendung des Schlingstiches ist ganz unterschiedlich: Er wurde zum Festnähen des Saums verwendet, zum Versäumen von Kanten, ebenso fand er Verwendung beim Nähen verschiedener Nähte und beim Einsetzen von Flicken.
Ein Beispiel für den Schlingstich ist ein Fund[5] aus dem Kernverwässerungswerk. Das 1849 gefundene Gewebe aus olivgrüner Wolle von 4 x 9 cm Größe datiert hallstattzeitlich. Der relativ feine Stoff mit unregelmäßigem Spinnrichtungsmuster hat einen 5 mm breiten Rollsaum. Der 0,4 mm starke S-Nähfaden hat dieselbe Farbe wie das Gewebe. Der Saum wurde mit einer sehr dichten Stichfolge normal zum Saum ausgeführt, wobei die Schnittkante zuerst dicht umnäht, anschließend umgeschlagen und festgenäht wurde[6].

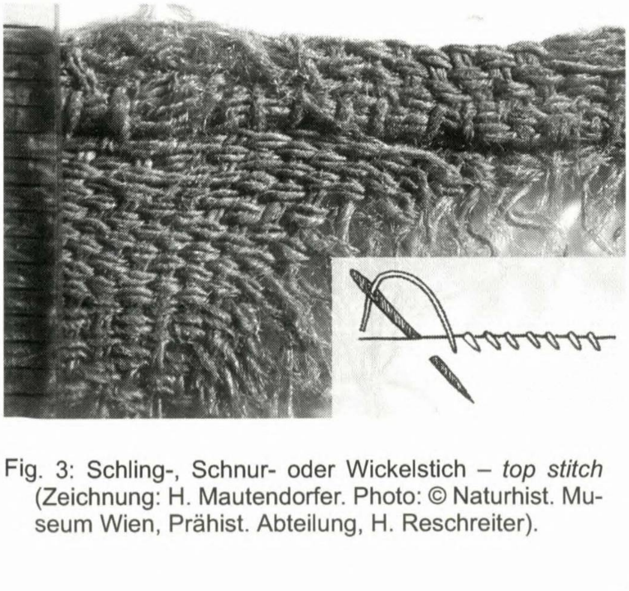

Fig. 3: Schling-, Schnur- oder Wickelstich – *top stitch* (Zeichnung: H. Mautendorfer. Photo: © Naturhist. Museum Wien, Prähist. Abteilung, H. Reschreiter).

Ein anderes Beispiel[7] für den Schlingstich wurde im Kilbwerk geborgen. Das gelblich-braune Wollgewebe hat einen Saum, der lockerer als das vorige Beispiel mit einem Stichabstand von 3-5 mm genäht wurde.
Wenn die Stiche ganz dicht nebeneinander genäht werden, entsteht eine Schnuroptik. Ein Beispiel dafür[8] stammt aus dem Kilbwerk (Fig. 13/Detail, Plate 9/2). Das 1966 gefundene 30,7 x 17 cm große Wollstück mit einem aufgenähten Flicken ist ein interessantes Stück, das zu den verschiedenen Bindungen (Panama und Köper mit Spinnrichtungsmuster) auch verschiedene Nähte bzw. Sticharten aufweist. Der Flicken ist mit einem Schlingstich angenäht. Die sehr dicht gearbeiteten Stiche wurden abwechselnd in zwei Farben mit 0,3 mm starkem Zwirn ausgeführt (blau in S-Zwirn, weiß in Z-Zwirn). Unter den Schlingstichen wurden mehrere Fäden mitgeführt[9], eventuell wollte man so den Schnureffekt noch verstärken.

Der Vorstich

Der einfachste in Hallstatt belegte Stich ist der Vorstich. Der Stich entsteht, wenn die Nadel in gleichmäßigen Abständen über und unter dem Grundstoff durchläuft (Fig. 2). Dieser einfache Stich kommt bei den Hallstattfunden allerdings recht selten vor.
Ein Beispiel für den Vorstich ist ein bronzezeitlicher Fund[10] aus dem Grünerwerk (Fig. 2/rechts). Das 1926 gefundene Fragment eines hellbraunen Wollgewebes ist 19 x 5 cm groß. An beiden Längskanten findet man einen mit Vorstich durchgezogenen Faden. An der unteren Kante wurde das 2 mm S-Garn in langen Stichen genäht. An der

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[5] Inventurnummer des Naturhistorischen Museums 73.341, nach Hundt: Fundnummer 16.

[6] Vgl. Hundt 1959: 78-79.

[7] Inventurnummer des Naturhistorischen Museums 75.818b.

[8] Inventurnummer des Naturhistorischen Museums 75.955, nach Hundt: Fundnummer 64.

[9] Vgl. Hundt 1967: 46-48.

[10] Inventurnummer des Naturhistorischen Museums 73.244, nach Hundt: Fundnummer 45.

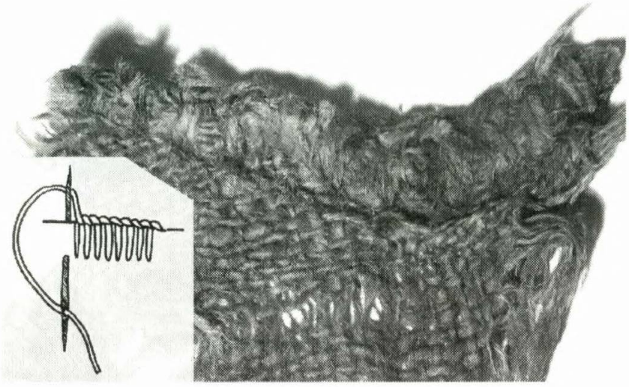

Fig. 4: Knopflochstich – *blanket stitch or buttonhole stitch* (Zeichnung: © H. Mautendorfer. Photo: © Naturhist. Museum Wien, Prähist. Abteilung, H. Reschreiter).

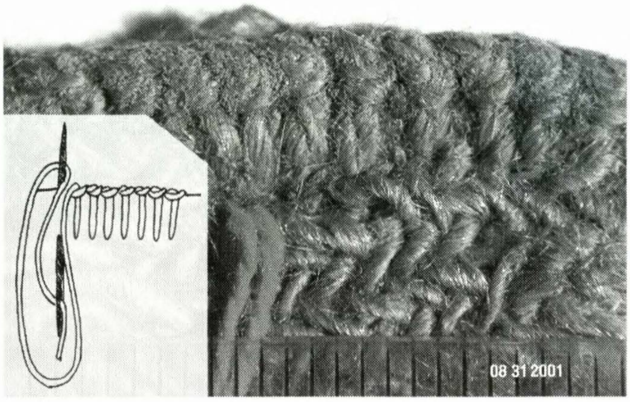

Fig. 5: Knopflochstich-Variante – *blanket stitch, buttonhole stitch* (Zeichnung: © H. Mautendorfer. Photo: © Naturhist. Museum Wien, Prähist. Abteilung, H. Reschreiter).

oberen Kante nähte man unregelmäßige Stiche mit einem 2-3 mm starken Z-Zwirn[11].

Der Stielstich

Ein einziger Fund belegt den Stielstich (Fig. 6, Plate 9/2). Das Gewebe[12] wurde 1966 im Kilbwerk geborgen. Das braune Textilfragment mit dem eingesetzten Flicken verfügt über einen 5 mm breiten Rollsaum. Auf dem äußeren Kantenumbruch befinden sich vier Stielstichreihen in den Farben blau und weiß. Die mit 0,4 mm starkem Zwirn genähten Stielstiche wurden zur Verzierung der Kante als Ziernähte eingesetzt[13].

Der Knopflochstich

Der Kopflochstich dient zum Einfassen von Kanten. Er wird längs der Kante genäht, wobei jeder Stich mit dem vorherigen verschlungen wird.
Es gibt zwei Belege von Knopflochstichen aus Hallstatt. Der bronzezeitliche Fund[14] aus dem Christian-Tuschwerk hat einen mit Knopflochstichen umnähten Saum (Fig. 4). Der zweite Fund[15] stammt aus dem hallstattzeitlichen Kilbwerk und zeigt eine Variante des Knopflochstiches[16]. Hier wurde der Faden von der anderen Richtung als beim normalen Knopflochstich über die Nadel gelegt, was zu einer flechtartigen Oberkante führt (Fig. 5). Optische Ähnlichkeiten zu dem kretischen Federstich und zum „*basket-stitch*" sind hier zu beobachten.

Nähte und Säume

Die Nähte

Bei den prähistorischen Hallstatt-Textilien kommen einfache Nähte, einfache Nähte mit versäumten Kanten, sowie Kappnähte vor.
Bei den einfachen Nähten mit versäumten Kanten (Fig. 7) – so zum Beispiel beim hallstattzeitlichen Fund[17] aus dem

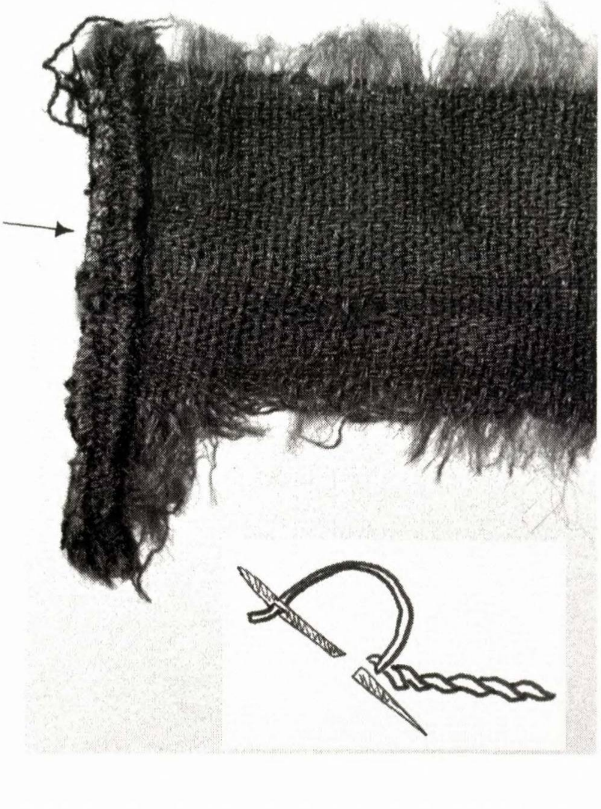

Fig. 6: Stielstich – *stem stitch* (Zeichnung: © H. Mautendorfer. Photo: © Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter).

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[11] Vgl. Hundt 1967: 39.

[12] Inventurnummer des Naturhistorischen Museums 75.955, nach Hundt: Fundnummer 64.

[13] Vgl. Hundt 1967: 46-48.

[14] Inventurnummer des Naturhistorischen Museums 94.849.

[15] Inventurnummer des Naturhistorischen Museums 79.429, nach Hundt: Fundnummer 96.

[16] Vgl. Hundt 1987: 264-265.

[17] Inventurnummer des Naturhistorischen Museums 75.816, nach Hundt: Fundnummer 55.

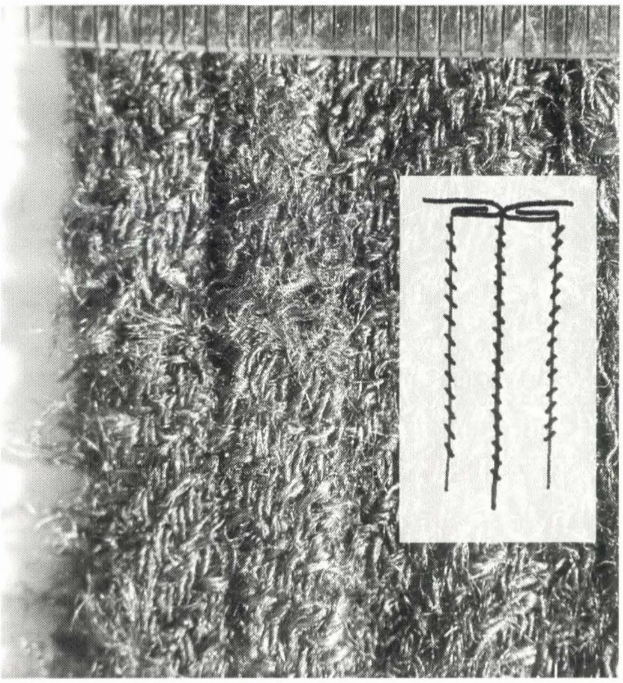

Fig. 7: Einfache Naht mit versäumten Kanten – *simple seam* (Zeichnung: © H. Mautendorfer. Photo: © Naturhist. Museum Wien, Prähist. Abteilung, H. Reschreiter).

Kilbwerk – wurden zuerst die Kanten versäubert und anschließend zusammengenäht. 1964 wurden die drei zusammengenähten schwarzbraunen Wollfragmente geborgen. Der Textilfund mit Spinnrichtungsmuster ist 16,5 x 9,6 cm groß. Die Kanten wurden eingerollt und anschließend mit Schlingstichen zusammengenäht. Die Nähte sind mit weinrotem S-Zwirn gearbeitet, der Stichabstand beträgt 3 mm[18].

Eine recht häufig vorkommende Nahtform ist die Kappnaht (Fig. 8, Plate 11/1). Ein hallstattzeitliches Beispiel für eine Kappnaht ist der folgende Fund[19]: Das olivfarbene, 14 x 8,5 cm große Wollgewebe wurde 1989 im Kernverwässerungwerk geborgen. Die Kappnaht wurde beidseitig mit doppelt genommenem hell olivfarbenem S-Garn von 0,2 mm Stärke genäht. Der Stichabstand beträgt 3-4 mm[20].

Die Nähte sollen nicht nur die Stoffe verbinden, sondern haben oft auch eine dekorative Funktion. Bei Nähfäden, die bei einer primären Naht im Farbkontrast zum Gewebe gewählt wurden, kann man ebenfalls mit einer Ziermotivation rechnen. Ein besonders eindeutiges Beispiel einer solchen Ziernaht findet man auf dem oben bereits erwähnten Fund 75.955[21]. Die Naht wurde abwechselt in zwei Farben, blau und weiß, gestaltet (Plate 9/2).

Bei den genähten Textilien aus dem prähistorischen Hallstatt ist auch eine sekundäre Verwendung nachzuweisen. Manche der Nähte scheinen noch in primärem Verarbeitungszustand zu stehen, die Nähte sind mit gleichmäßigen, gleichfarbigen Stichen gearbeitet. Andere Funde zeigen neben diesen feinen Nähten auch grobe und ungleichmäßige Nähte, oft in einem stärkeren andersfarbigen Nähfaden gearbeitet[22]. Hier kann man von sekundären Nähten sprechen. Diese Nähte sind vor allem Zeugnis der Wiederverwertung von textilem Material, bis es schließlich nicht mehr brauchbar war oder verloren gegangen im Bergstollen liegen blieb (Plate 8/4).

Die Säume

In Hallstatt finden wir grundsätzlich zwei Arten von Säumen:

Zweimal umgeschlagene Säume, die mit Schlingstichen in einem Abstand von meistens 3-6 mm angenäht wurden (Fig. 9) und einmal umgeschlagene Säume, bei denen die offene Kante dicht an den Unterstoff ebenfalls mit Schlingstichen angenäht wurde (Fig. 10).

Die meisten Saumreste sind parallel zur Fadenrichtung orientiert. Doch gibt es aus dem Fundbestand auch einen

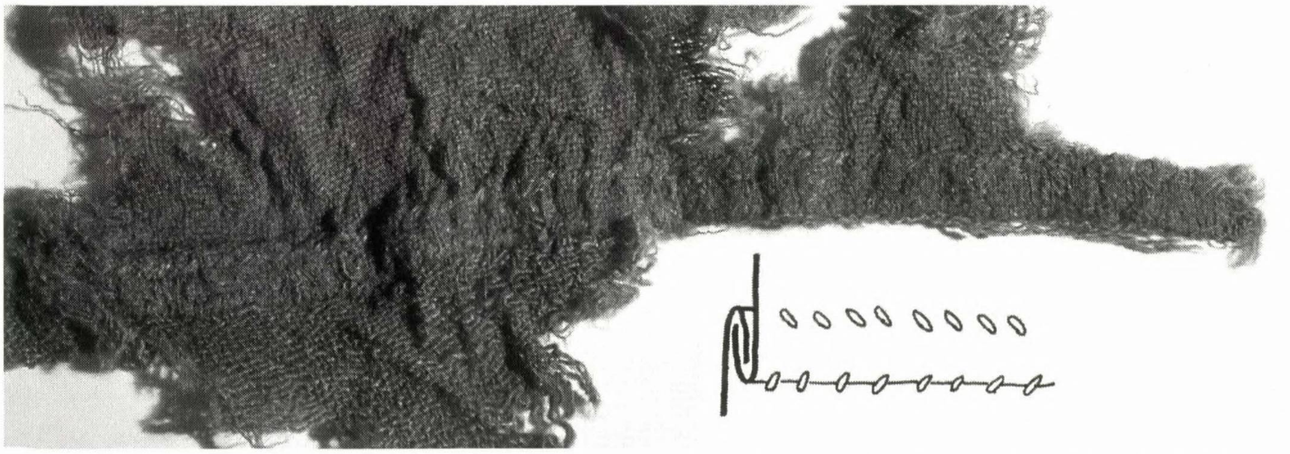

Fig. 8: Kappnaht – *fell seam* (Zeichnung: © H. Mautendorfer. Photo: © Naturhist. Museum Wien, Prähist. Abteilung).

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[18] Vgl. Hundt 1967: 42-43

[19] Inventurnummer des Naturhistorischen Museums 89.088.

[20] Vgl. Kurzynski, unpublizierter Katalog 1986-1991.

[21] Vgl. Hundt 1967: 46-48.

[22] Zum Beispiel: Inventurnummer des Naturhistorischen Museums 79.436 aus dem Kilbwerk. Vgl. Hundt 1987: 266.

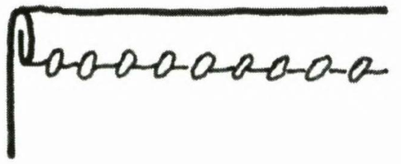

Fig. 9: Zweimal umgeschlagener Saum – *the edge is either folded twice* (© H. Mautendorfer).

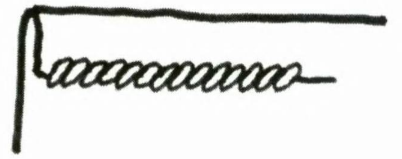

Fig. 10: Einmal umgeschlagener Saum – *the edge is either folded once* (© H. Mautendorfer).

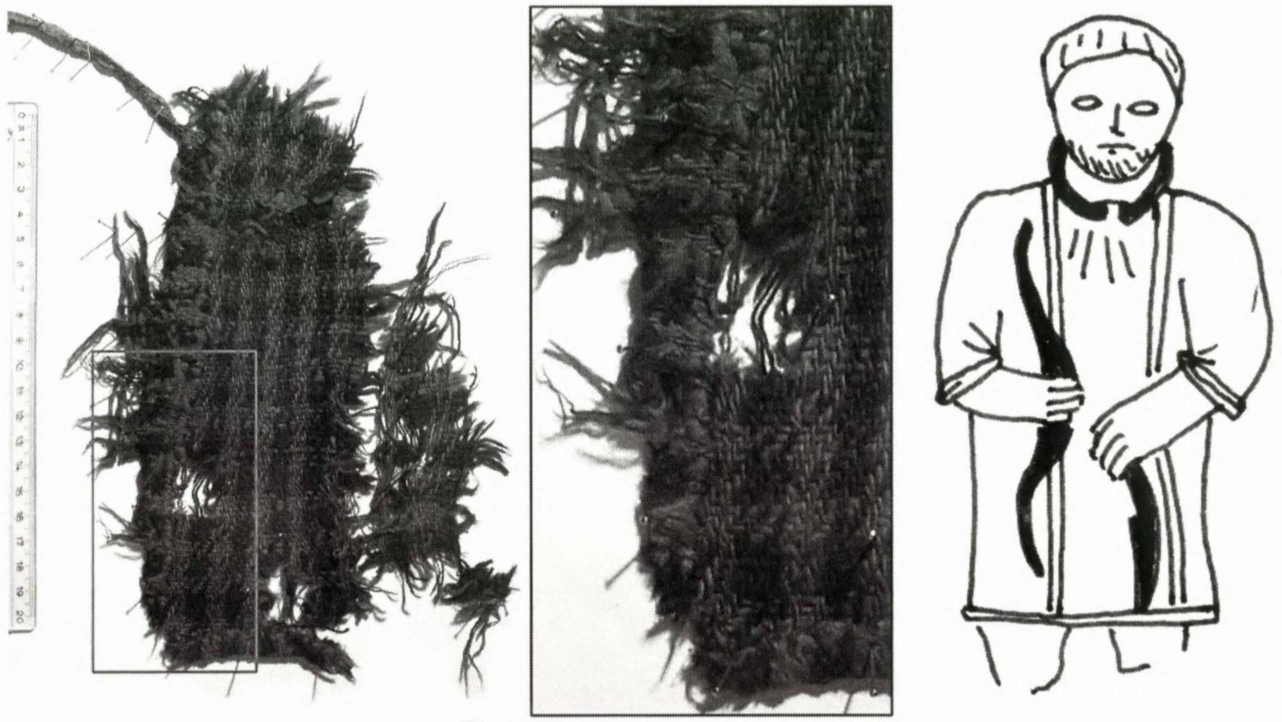

Fig. 11: Naht normal auf Saum – *Fell seam meets Hem*: Gewebe aus Hallstatt (mit Detail) im Vergleich zu einer Darstellung eines keltischen Jagdgottes aus Sarthe, Frankreich (Photo: © Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter. Zeichnung: © H. Mautendorfer).

runden Saum (Plate 11/5)[23] und einen Saum, der eckig gearbeitet ist, von einem fadengeraden Stück zu einem schrägen Stück (Plate 11/3)[24]. Diese Details lassen manche Vermutungen zur Schnitttechnik zu. So muss man in der Hallstattzeit auch mit runden Säumen, vielleicht im Bereich des Halses oder des Ärmels, sowie mit eckigen Abschlüssen rechnen.

Flickungen

Ein wichtiger Aufgabenbereich des Nähenden ist auch das Ausbessern von Kleidung durch Flicken und Stopfen. Für beide Tätigkeiten gibt es Belege auf den Textilfunden aus Hallstatt. Der hallstattzeitliche Fund[25] aus dem Enderwerk zeigt eine Flickstelle. Hier wurde ein rechteckiger Flicken aufgenäht, wobei versucht wurde, auf das Muster des Ausgangsmaterials Rücksicht zu nehmen (Plate 10/1)[26].
Ein bronzezeitliche Fund[27] aus dem Grüner-Werk zeigt neben der Naht eine leinwandbindige Stopfung(Plate 10/2)[28].

Besondere Funde

Im Folgenden wird nun eine Auswahl von Funden vorgestellt, bei denen mehrere Nähte oder Säume vorkommen oder die aufgrund ihrer Form oder Details besondere An-

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[23] Inventurnummer des Naturhistorischen Museums 77.569, vgl. Hundt 1987: 262.

[24] Inventurnummer des Naturhistorischen Museums 75.989b, vgl. Hundt 1967: 50-51 und Fund 34 (nach Hundt), vgl. Hundt 1960: 139-141.

[25] Inventurnummer des Naturhistorischen Museums 73.346, nach Hundt: Fundnummer 30.

[26] Vgl. Hundt 1960: 132-133.

[27] nach Hundt: Fundnummer 44.

[28] Vgl. Hundt 1960: 146.

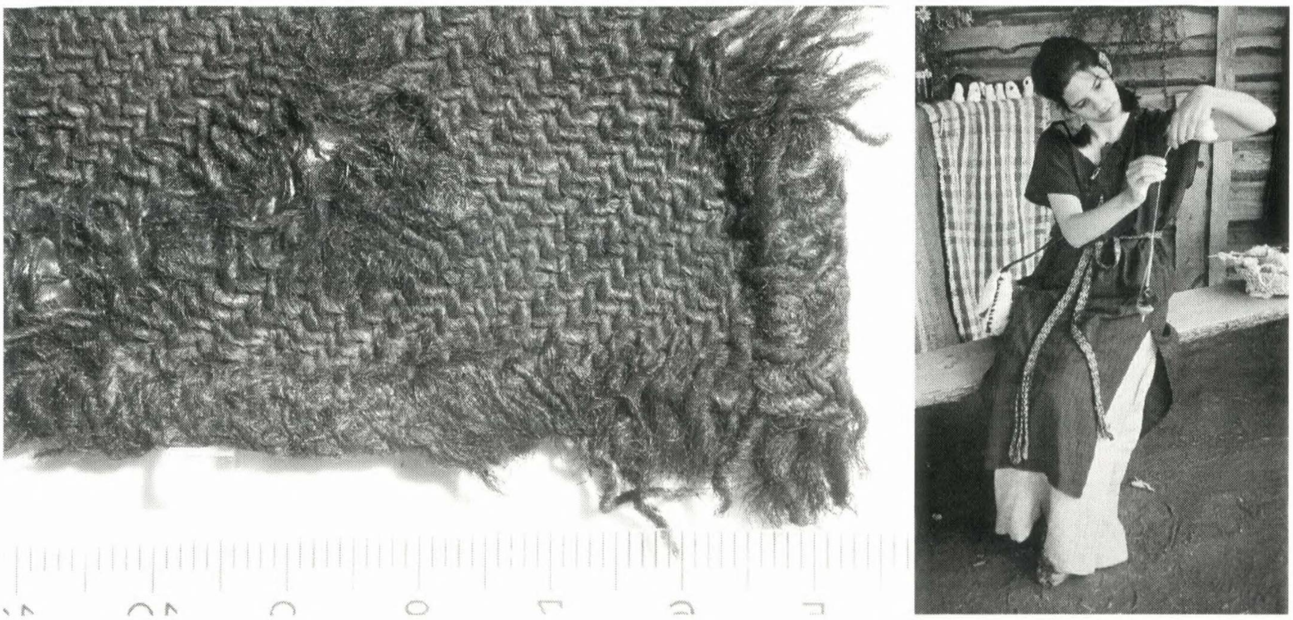

Fig. 12: Saum normal auf Saum – *Hem meets Hem*: Detail eines Gewebes aus Hallstatt, im Vergleich dazu ein einfaches Gewand, an dem mögliche Lagen einer derartigen Ecke erkennbar sind (am seitlichen Schlitz oder am Halsausschnitt) (Photo links: © Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter. Photo rechts: © K. Grömer).

haltspunkte für die prähistorische Nähtechnik und in weiterer Folge für die Kleidung der damaligen Zeit aufzeigen. Neben den textilen Resten können wir auch Hinweise auf die Kleidung bei figürlichen Abbildungen der damaligen Kunst finden. Diese Darstellungen sind meistens nicht naturalistisch, sondern abstrahiert; dennoch weisen manche der folgenden Funde schöne Parallelen zur eisenzeitlichen Kunst auf.

Naht normal auf Saum[29]

1882 wurde im Josef Ritschner-Sinkwerk ein karierter hallstattzeitlicher Wollrest gefunden (Plate 9/1, Fig. 11). Der braun-olivgrüne gemusterte Stoff ist ca. 14,5 x 24 cm groß. Auf dem Stück befindet sich eine Kappnaht, die zwei Teile des gleichen Gewebes miteinander verbindet. Mit einem Zwirn aus hellgrüner Wolle wurden mit Schlingstichen im Abstand von 5 mm die Teile zusammengefügt. Normal zur Naht verläuft ein 1 cm breiter Saum, der ebenfalls mit Schlingstichen im Abstand von 3-5 mm genäht wurde. Der Kreuzungspunkt des Saumes mit der Naht ist leider nicht mehr erhalten, da der Stoff dort beschädigt und ausgefranst ist[30] (Fig. 11, links).

Die normal zum Saum stehende Naht könnte ein Hinweis auf eine gerade Teilungsnaht bei einem Kleidungsstück sein. So könnte man sich einen Kittel wie bei der Darstellung eines keltischen Jagdgottes aus Sarthe[31] (Frankreich) mit geraden Teilungsnähten vorstellen (Fig. 11, rechts). Es gibt natürlich auch andere Interpretationsmöglichkeiten für eine derartige Naht, wie zum Beispiel der untere Teil einer Seitennaht eines Kleidungsstückes oder einer Ärmelnaht.

Saum normal auf Saum[32]

Im Jahre 1846 wurde dieser hallstattzeitliche Wollstoffrest aus dem Kernverwässerungswerk geborgen (Fig. 12, Plate 11/4). Der 6 x 10 cm große Textilfund aus brauner Wolle hat einen 7 mm breiten Rollsaum, der über die Ecke im rechten Winkel verläuft. Der durchschnittliche Stichabschnitt der normal zum Saum ausgeführten Stiche beträgt 3,5 mm. Die Ecke ist leider ausgefranst[33] (Fig. 12, links).

Mehrere Erklärungen bieten sich auch für diesen Fund an: Zum einen könnte man eine derartige rechtwinklige Ecke an einer rechteckigen Decke oder an einem rechteckigen Umhang finden. Eine andere Möglichkeit wäre meines Erachtens auch ein Schlitz am Saum eines Oberteiles oder eines Halsausschnittes (Fig. 12, rechts). Allerdings sind mir keine vergleichbaren Abbildungen aus der damaligen Kunst bekannt, die jedoch nicht besonders viele detailreiche menschliche Abbildungen bietet.

Vom praktischen Nutzen her sind Schlitze nicht von vornherein auszuschließen, denn die so gegebene Bewegungsfreiheit ist enorm und gerade beim Arbeiten von Vorteil. Dazu kommt, dass ein Schlitz beim Halsausschnitt – vorausgesetzt er ist lang genug und eventuell mit Bändern

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[29] Inventurnummer des Naturhistorischen Museums 73.344, nach Hundt: Fundnummer 19.

[30] Vgl. Hundt 1959: 82-85.

[31] Abbildung Vgl. Cunliffe 1980: 66. Der Fundort Sarthe wird in der Literatur teilweise auch unter Lacellemont Saint Jean geführt.

[32] Inventurnummer des Naturhistorischen Museums 73.340, nach Hundt: Fundnummer 15

[33] Vgl. Hundt 1959: 78.

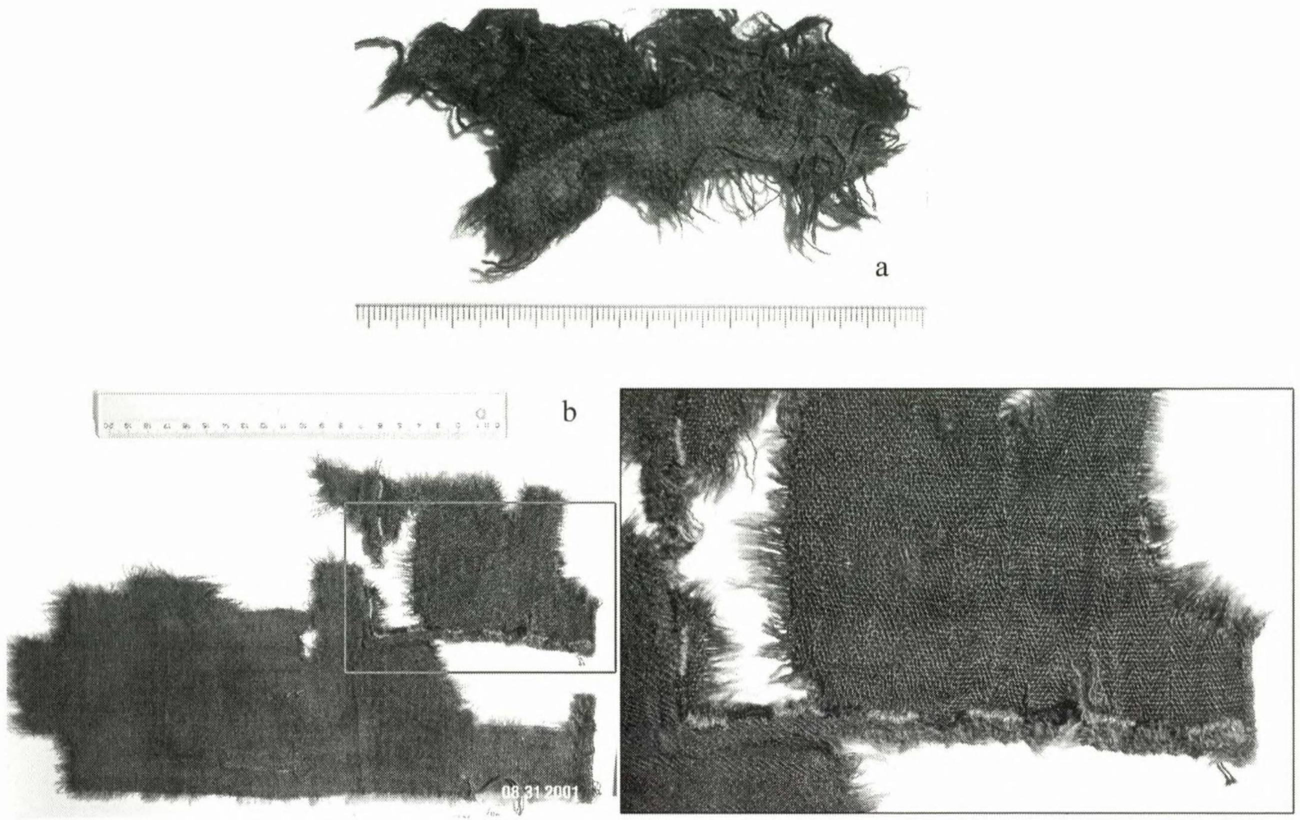

Fig. 13: Rechteckiger Einsatz – *Rectangular patch*: Zwei Beispiele aus Hallstatt (mit Detail). – a: das Gewebe ist durch die Lagerung stark verzogen (© Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter).

oder einer Fibel verschließbar – vor allem für das Stillen von Babys von Vorteil ist.

Rechteckiger Einsatz

Ein anderes Konstruktionselement ist der Einsatz von rechteckigen Stoffteilen. Bei zwei Funden kommt ein eindeutig rechteckig eingesetztes Stück Stoff vor.

Folgender Fund[34] wurde 1992 aus dem Kernverwässerungswerk geborgen (Fig. 13a, Plate 11/2). Der hallstattzeitlich datierende Textilrest ist aus zwei unterschiedlichen Stoffen zusammengesetzt, einer in Leinwandbindung, der andere in Panama. Auch farblich sind die zwei Stoffe unterschiedlich. Der hellere Stoff in Panamabindung wurde im rechten Winkel eingesetzt, er ist jetzt durch die Lagerung stark verzogen. Sorgfältig wurden die Kanten versäubert; die Naht wurde mit einem grünen Zwirn mit Schlingstichen in einem Abstand von 3-5 mm ausgeführt.

1966 wurde ein ähnlicher Fund[35] aus dem Kilbwerk geborgen (Plate 9/2, Fig. 13b). Der eingesetzte Teil wurde sorgfältig mit einem dichtem Schlingstich eingenäht. Der zweifarbige Stich ist nur auf einer Seite sichtbar. Mit derselben Sorgfalt wurde neben dem Einsatz der Saum gearbeitet und auf der Saumkante mit farbigen Stielstichen verziert[36]. Diese Saumkante war also mit einem rechteckigen Einsatz geschmückt. An welcher Stelle eines Gewandes sich dieser Saum befunden hat, ist nicht mehr nachvollziehbar.

Beide Teile weisen eine Ähnlichkeit in puncto Verzierung auf. Der Einsatz bei Fund 75.955 ist durch die zweifarbige Naht besonderes herausgehoben, bei Fund 90.132 sticht der Einsatz durch die andere Farbigkeit und die andere Bindung des Stoffes heraus. Es ist durchaus möglich, dass solche Einsätze als Schmuck- und Konstruktionselemente der damaligen Tracht verwendet wurden.

Zusammengenähte Borte[37]

1990 stieß man im Kernverwässerungswerk auf einen in mehrerer Hinsicht großartigen Fund. Es handelt sich dabei um eine 1,3 cm breite und 22 cm lange Brettchenborte (Plate 7/5, Fig. 14a). Die hallstattzeitlich datierende Borte war zusammengenäht und zudem auch an einen Köperstoff genäht, von dem nur mehr spärliche Reste erhalten sind. Die kompliziert gemusterte Borte wurde durch Rosshaarfäden im Schuss verstärkt. Zusammengenäht wurde die Borte mit einem 0,5 cm dicken Zwirn, angenäht wurde sie an einem Köpergewebe mit olivfarbenem doppelt genommenem Zwirn[38].

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[34] Inventurnummer des Naturhistorischen Museums 90.132.

[35] Inventurnummer des Naturhistorischen Museums 75.955, nach Hundt: Fundnummer 64.

[36] Vgl. Hundt 1967: 46-48.

[37] Inventurnummer des Naturhistorischen Museums 89.832.

[38] Vgl. Grömer 2001: 49–58. – Vgl. Kurzynski 1998: 40-41.

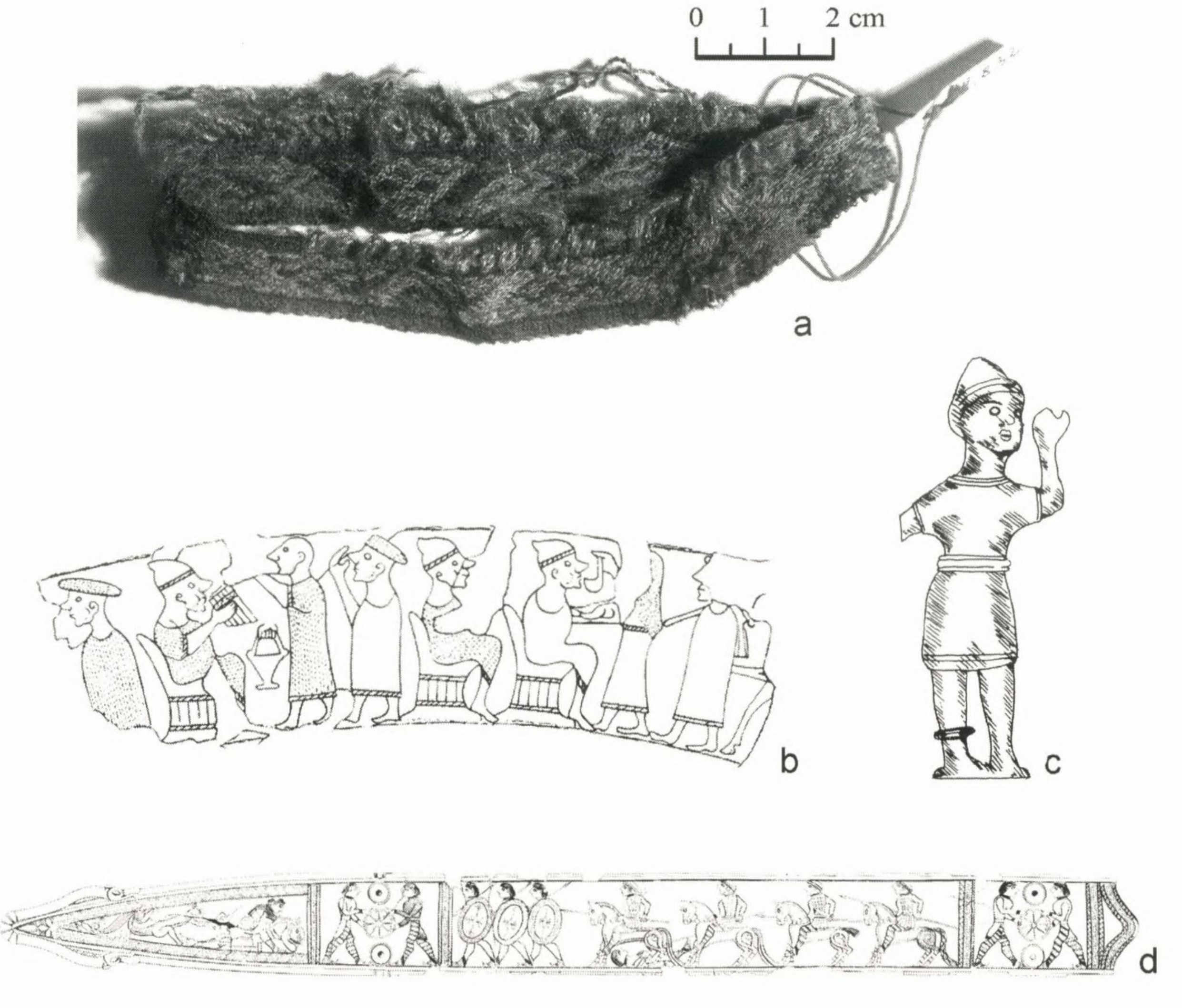

Fig. 14: Zusammengenähte Borte – *Sewn-on Braid*: Zusammengenähtes Brettchengewebe aus Hallstatt im Vergleich zu hallstattzeitlichen Abbildungen mit Borten am Saum der Gewänder: b: Ausschnitt der Situla von Magdalenska Gora. – c: Figur von Idria. – d: Schwertscheide von Hallstatt (Photo: a: © Naturhistorisches Museum, Prähist. Abteilung. – b: und d: nach Ausstellungskatalog „Krieger und Salzherren", Tafel 61, 78. – c: © H. Mautendorfer).

Als Funktion kommt bei der Borte die Verwendung als Abschlussborte oder Besatz in Frage. Ob die Borte allerdings nur aus einer Ziermotivation heraus verwendet worden ist oder etwa, um die Gewandkante zu schonen (oder beides), ist nicht beantwortbar.

Genauso wenig lässt sich der ehemalige Anbringungsort der Borte exakt lokalisieren. Die Borte könnte am Ärmel oder auch an einem Hosenbein angenäht gewesen sein.

Hinweise für Borten sind auch in der zeitgenössischen Kunst zu beobachten. Abbildungen von Borten findet man auf den Situlendarstellungen[39] (Fig. 14b). Andere Beispiele sind die aufgenähten Borten an den Oberteilen der Figuren auf der Schwertscheide aus Hallstatt[40] (Fig. 14d) und die angedeuteten Ärmelborten auf einer Statue von Idria[41], die anscheinend auch an Halsausschnitt und Saum Borten trägt (Fig. 14c).

Aufgenähtes Band[42]

1993 stieß man im Kernverwässerungswerk auf ein braunes, mit Karomuster versehenes Textil, das auf der Rückseite ein mit doppeltem Faden angenähtes Band aufweist

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[39] Vgl. Ausstellungskatalog „Krieger und Salzherren" 1970: Tafel 59-66.

[40] Vgl. Ausstellungskatalog „Krieger und Salzherren" 1970: Tafel 78-81.

[41] Kurzynski 1996: Abb. 41. Ausgestellt in der Schausammlung des Naturhistorischen Museums Wien.

[42] Inventurnummer des Naturhistorischen Museums 90.182. Dieses Stück wurde in Rautenköper angefertigt.

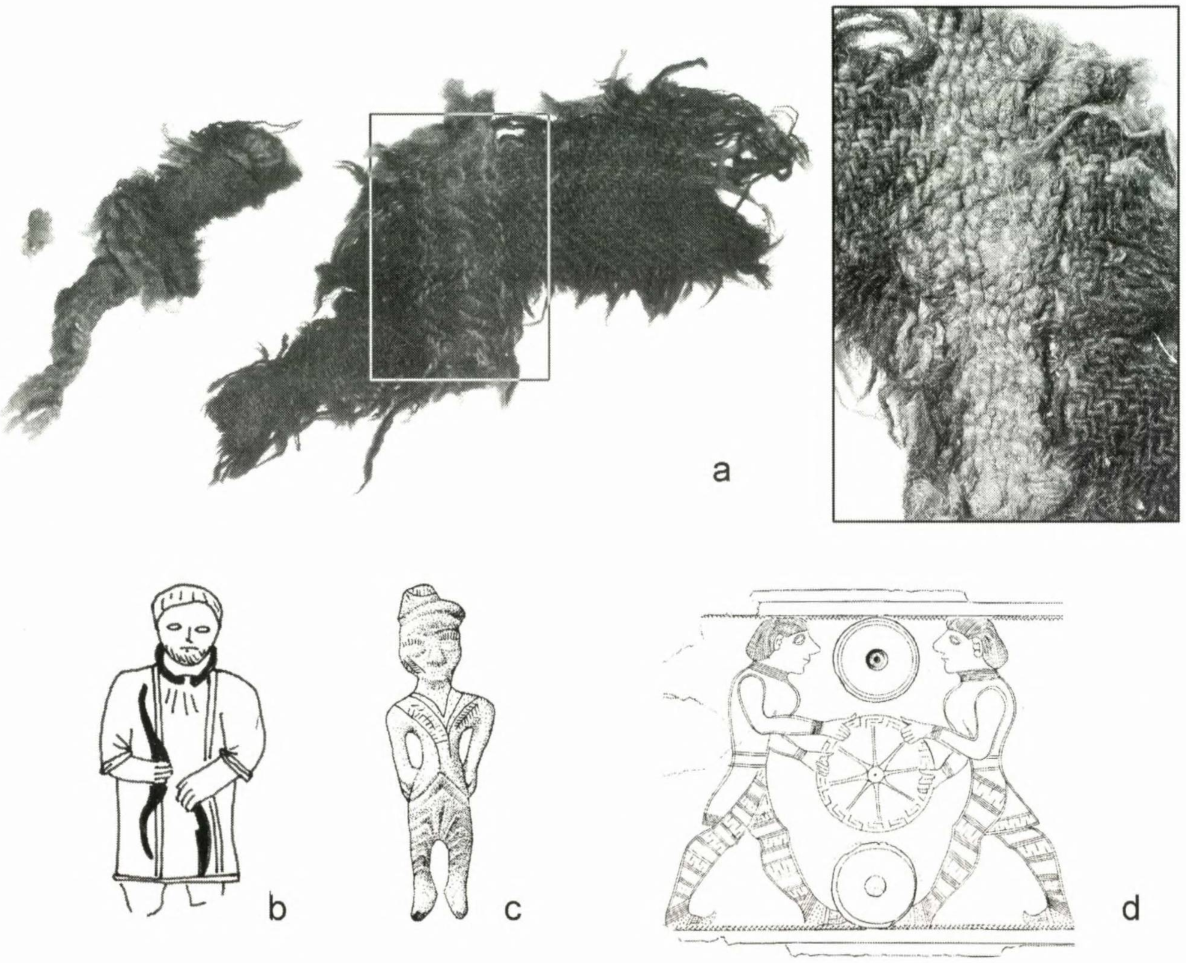

Fig. 15: Aufgenähtes Band – *Sewn-on band*: a: Gewebe aus Hallstatt mit einem an der Rückseite aufgenähten Band (siehe Detail oben rechts). – b: Figur von Sarthe, die Linien könnten ein aufgenähtes Band sein. – c: Fibel vom Dürrnberg, Faltung an der Hose möglicherweise durch aufgenähtes Band an der Innenseite und durchgezogener Kordel. – d: Schwertscheide von Hallstatt, möglicherweise aufgenähte Bänder an den Hosen (Photo: a: © Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter. – b: © H. Mautendorfer. – c: nach Kurzynski 1996, 51. – d: nach Ausstellungskatalog „Krieger und Salzherren", Tafel 78).

(Fig. 15a, Plate 5/2). Angenäht ist das Band an beiden Längsseiten mit Schlingstichen in einem Abstand von ca. 3 mm. Es stellt sich an dieser Stelle die Frage nach dem möglichen Sinn dieses Bändchens. Da es in der Stoffmitte angebracht ist, dient es nicht zur Verstärkung, wie das zum Beispiel bei Bändern an den Kleidungskanten der Fall ist, die die Stoffkanten vor Verschleiß durch Abstoßen schützen und bei Bedarf ausgewechselt werden können.

Eine Interpretationsmöglichkeit wäre, dass das Band zur Zierde angebracht wurde. Auch wenn das Band etwas unregelmäßig erscheint, ist es nicht auszuschließen, dass es ein Zierband war. Die schon oben erwähnte Abbildung des keltischen Jagdgottes aus Sarthe (Fig. 15b)[43] zeigt einen Kittel, bei den darauf abgebildeten Längslinien könnte es sich auch um aufgenähte Zierbänder handeln. Auch die Linien auf den Hosen von den menschlichen Figuren auf der Schwertscheide aus Hallstatt[44] könnten als solche aufgenähten Bänder interpretiert werden (Fig. 15d).

Eine andere Möglichkeit wäre auch, dass man eine Schur durch das aufgenähte Band gezogen hat, um etwas an dieser Stelle zusammenzuziehen. Reste einer durchgezogenen Schnur wurden allerdings nicht gefunden. Eine Fibel vom Dürrnberg zeigt jedoch eine menschliche Figur mit faltigen Hosen[45]. Diese Falten könnten durch das Zusammenziehen von Schnüren unter einem Band gebildet werden (Fig. 15c).

Aus mehreren Teilen zusammengesetzt[46]

Der größte Fund stammt aus dem Enderwerk und wurde vor 1901 entdeckt (Plate 9/3, Fig. 16a). Das hallstattzeitliche Textil ist ca. 55 x 55 cm groß und wurde aus sechs Teilen zusammengesetzt. Die Teile 1, 2, 3 sind großflächig erhalten, von den übrigen Teilen hat man nur mehr geringe Reste und die Nähte.

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[43] Vgl. Cunliffe 1980: 66.

[44] Vgl. Ausstellungskatalog „Krieger und Salzherren" 1970: Tafel 78-81.

[45] Vgl. Kurzynski 1996: 51.

[46] Inventurnummer des Naturhistorischen Museums 73.347, nach Hundt: Fundnummer 31.

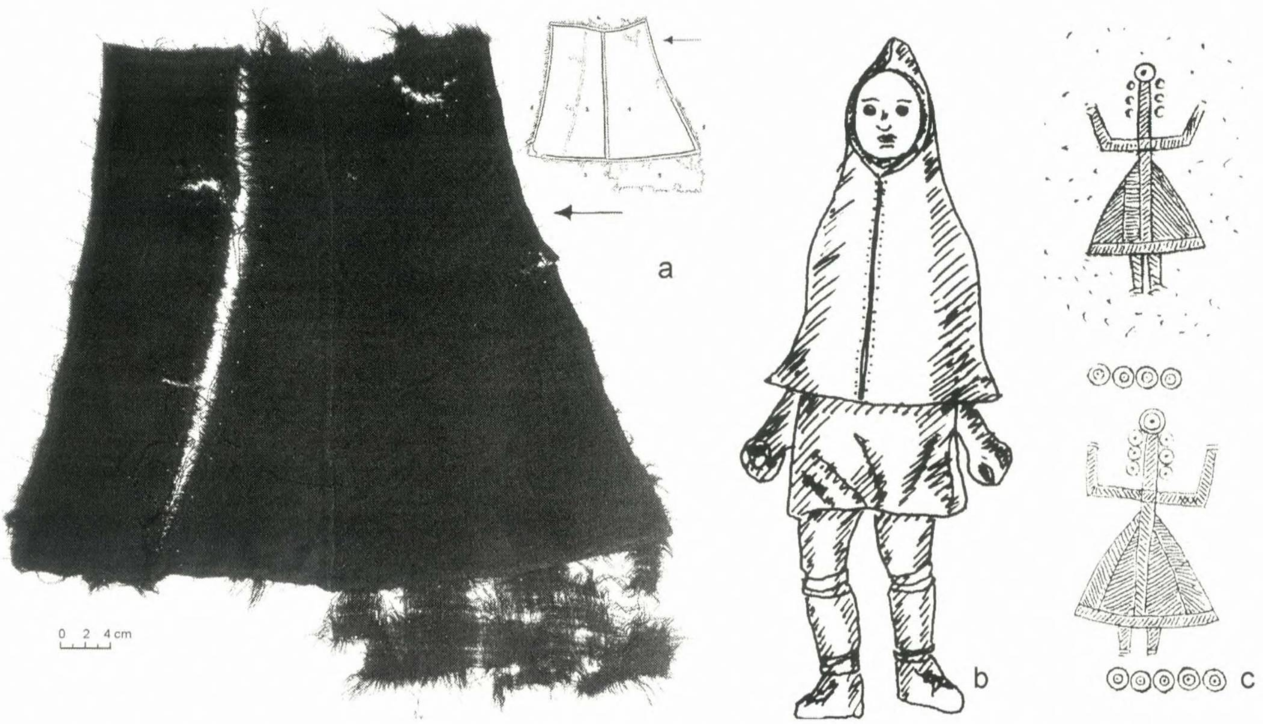

Fig. 16: Aus mehreren Teilen zusammengesetzt – *Sewn together out of multiple pieces*: a: Großes Gewebe aus Hallstatt. – b: Britannische Statue mit Kapuzenmantel. – c: Ritzzeichnungen auf Kegelhalsgefäßen aus Sporon (Ungarn) (Photo: a: © Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter, Zeichnung nach Hundt 1960. – b: H. Mautendorfer. – c: nach Eibner 1997: Abb. 4) .

An allen Außenkanten befinden sich Nähte, mit Ausnahme eines 26 cm langen Stückes, das anscheinend als Kleidungsöffnung diente (Fig. 16a, Pfeil). Die Mittelnaht zwischen den Gewebeteilen 1 und 2 ist ebenso wie das Nahtstück zwischen den Teilen 5 und 1 eine angenähte Schlauchkante, die restlichen Nähte sind Kappnähte[47].

Für die Funktion dieses Fragmentes eines Kleidungsstückes ist bis jetzt noch keine befriedigende Antwort gefunden worden. Es könnte sich um einen Kittelteil mit Armausschnitt oder um einen Ärmel handeln, aber auch ein kapuzenförmiges Kleidungsstück – ähnlich einer britannischen Statue[48] – könnte meiner Meinung nach möglich sein (Fig. 16b).

Aus mehreren Teilen zusammengesetzte Gewänder dürften nicht selten gewesen sein, sie begegnen uns auch in der hallstattzeitlichen Kunst – zum Beispiel bei den Ritzzeichnungen auf Soproner Kegelhalsgefäßen[49] (Fig. 16c).

Schlussfolgerung

Die Funde aus Hallstatt zeigen eine Vielzahl an Genähtem auf. Verschiedene Sticharten, Naht- und Saumtypen werden dokumentiert. Auch die unterschiedlichen Nähbereiche vom Zusammennähen und Säumen über das Verzieren durch Ziernähte bis zum Ausbessern durch Flicken und Stopfen können aufgrund der Textilfunde bestätigt werden. Funde mit mehreren genähten Elementen zeigen uns wiederum, dass man durchaus mehrere Stoffteile zusammengefügt hat. Dabei kann leider nicht geklärt werden, ob das aus modischen oder praktischen Gründen der Wiederverwertung älterer Sachen geschehen ist, da kein Vergleichsmaterial in Form ganzer Gewänder vorhanden ist.

Aufgrund der kleinen Textilreste kann man nichts über konkrete Kleidungsformen aussagen. Dennoch zeigen uns viele kleine Details den Variantenreichtum der damaligen Gewänder auf. So wie die unterschiedlichen Bindungsarten und Muster die Musterung und die unterschiedlichen Farben die Farbenfrohheit widerspiegeln, geben uns die verschiedenen Nähte und Säume eine Ahnung von der Vielfalt der Kleidungsformen und spezieller Nähtechniken.

Ohne das Heranziehen und kritische Betrachten zeitgenössischer Abbildungen von Menschen in Kleidung wird man sich nur aufgrund der textilen Reste keine Vorstellung von der damaligen Tracht machen können. Solche Abbildungen sind jedoch leider auch selten und dazu oft sehr abstrahiert. Dennoch zeigen die bekannten Abbildungen verschiede Kleidungsformen auf und der Variantenreichtum an Nähten und Säumen aus Hallstatt scheint zu diesem Bild zu passen.

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[47] Vgl. Hundt 1960: 134-137.

[48] Vgl. Birkhan 1999.

[49] Vgl. Eibner 1997: 131, Abb. 4.

Sewn Textiles from Prehistoric Hallstatt

Textiles play a very important role in the life of mankind. It is sad that there are only a few leads about the textile crafts of prehistory. The organic materials used decays in the ground, so there is not much proof of the textile production available. Textile finds in Central Europe are very rare. One of these extraordinary finds is the group of almost 3.500 year old textiles from the Hallstatt salt-mines. About 230 textile samples from the salt-mines tell us about the intricate crafts and the life of prehistoric man. The Bronze Age and Iron Age textiles feature a wide variety of minute differences in textures, patterns and colours. The textile samples document the sewing techniques used, and pieces with hems, seams, reedings and patches with varies stitches are common. Often small samples can reveal the complex textile skill used.

In prehistory, sewing plays a very important role. The use of needles and yarn to join leather, pelts and textiles was already common in the Stone Age[50]. Sewing was not just used to join and welt textiles. Artistic work such as reeding and embroidery is a very important part of sewing. The sewing on of braids[51] and other decorative elements, such as bronze buttons[52] or ornamental plates is the responsibility of the sewer. Other tasks such as repairing, mending and patching[53] of clothes must have played a very important role.

Sewing is the link between the uncut textile and the wearable piece of clothing. This often-neglected process is an important part of the production of clothes. Seams especially can tell us about the look and wearability of prehistoric clothes.

Starting with the stitching methods, seams and hems on the Hallstatt textiles, I will consider the variety of sewing in the Bronze and Early Iron Age. Afterwards I will consider some extraordinary finds under the heading of sewing. These finds should give a solid base for further discussions and research into the context of textile decoration and clothes in prehistory.

The Stitching Methods

Top Stitch

In Hallstatt the most common stitch is a diagonal stitch, the top stitch (Fig. 3). By making close or broad stitches it is possible to create different decorative effects.

The close stitches in the find 73.341[54] from the Kernverwässerungswerk from the Hallstatt period create the look of a rope. Another example is the find 75.955[55] from the Kilbwerk (Fig. 13). Here extra yarn under the stitches enhances the rope effect. The broad stitches with a stitch interval of 3-5 mm are more for functional than decorative use.

An example therefore is the find 75.818b[56] from the Kilbwerk. The top stitch has a variety of uses such as holding hems, hemming edges, sewing together fabrics or adding patches.

Running Stitch

The simplest stitch that has been found on Hallstatt textiles is the running stitch (Fig. 2). The stitch is made by alternating between the top and bottom of the fabric. The Bronze Age find 73.244[57] is one of the rare pieces having this stitch.

Stem Stitch

Stem stitch is rare, too (Fig. 6). This stitch is made by using a backstitch on the reverse side to create a line. This stitch is used for decorative purposes such as on the hem of the find 75.955[58] from the Kilbwerk (Fig. 13, Plate 9/2). Using alternating yarn colours the decorative effect was enhanced.

Blanket Stitch, also known as Buttonhole Stitch

It is used to frame the edges by sewing over the edge and sewing through the loop just created. Blanket stitch is documented on two textile samples.

The Bronze Age find 94.849[59] from the Christian-Tuschwerk shows one basic variant of blanket stitch (Fig. 4). The find 79.429[60] from the Kilbwerk shows another variant of blanket stitch. This variant is created by stitching through the reverse side of the loop (Fig. 5). This creates a braided effect that is similar to basket stitch.

Seams and Hems

The Seams

On prehistoric textiles we find simple seams, simple seams with hemmed edges and fell seams.

Simple seams are when two edges are sewn together. On the Hallstatt Period find 75.816[61] from the Kilbwerk, the edges were first hemmed and then seamed (Fig. 7).

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[50] Compare Stradal, Brommer: – 7-8. Wild 1988: 33.

[51] Compare Grömer 2001: 49-50.

[52] Compare Pertlwieser 1987: 64.

[53] Compare Hundt 1960: 149, a mended textile.

[54] Inventarnummer Museum of Natural History Vienna. Compare Hundt 1959: 78-79.

[55] Inventarnummer Museum of Natural History Vienna. Compare Hundt 1967: 46-48.

[56] Inventarnummer Museum of Natural History Vienna

[57] Inventarnr Mus. Natural History Vienna. Compare Hundt 1967: 39

[58] Inventarnummer Museum of Natural History Vienna. Compare Hundt 1967: 46-48.

[59] Inventarnummer Museum of Natural History Vienna.

[60] Inventarnummer Museum of Natural History Vienna. Compare Hundt 1987: 264-265.

[61] Inventarnr Mus. Natural Hist Vienna. Compare Hundt 1967: 42-43.

One of the most common seams is the fell seam. This seam is created by sewing edges that have been folded on top of each other. The textile no. 89.088[62] shows a fell seam, dated to the Early Iron Age, found in the Kernverwässerungswerk (Fig. 8, Plate 11/1).

Seams were not only used to hold together two edges. They were also used for decorative purposes. This was done by using different colours of yarn in the seam. A very good example of a decorative seam is a find 75.955[63] from the Kilbwerk. The seam has two different colours that were used alternately (Plate 9/2).

By examining the textiles from Hallstatt it was possible to see that recycling fabric was a common occurrence in the Bronze and Early Iron Age (Plate 8/4).

We consider seams as primary, if the find only contains seams with the same standard of craftsmanship. Some finds contain additional irregular and imprecise stitches that do not show the same craftsmanship as the primary seams. These are considered as secondary seams and give the impression that there has been a reuse of the fabric. Secondary seams usually have a different yarn colour and yarn thickness than the primary.

The Hems

In Hallstatt we basically find two different kinds of hems. The edge is either folded once (Fig. 10) or twice (Fig. 9). If they are only folded once they are sewn by using the close top stitch. Edges that are folded twice are sewn with a top stitch that has stitches 3 to 6 mm apart.

Most finds have hems that are parallel to the line of the thread; but there is one find that shows a round hem (Plate 11/5)[64], some with sewing at an angle to the thread course and with a corner (Plate 11/3)[65]. These hems must have been the result of the shape of cut. It is likely that cut-outs for arms and the throat were common. This should be taken into consideration when recreating clothes from the Hallstatt period.

Mending and Patching

An important aspect of needlework is the repairing of clothes through mending and patching. Patching can be seen on the Hallstatt period find 73.346[66] from the Enderwerk. There it is possible to see a rectangular patch that has a similar pattern to the main fabric (Plate 10/1). The Bronze Age find 44[67] from the Grünerwerk shows tabby weave mending, left under the seam (Plate 10/2).

Special Finds

I would like to mention finds where there are multiple seams and hems, or where the forms and intricate details give us an idea of prehistoric needlework in respect of clothing.

Fell seam meets Hem: find 73.344[68]

In 1882 a wool fragment was found in the Josef Ritschner-Sinkwerk (Plate 9/1). The brown olivegreen fabric is approximately 14 by 24 cm long. It has a fell seam that is joined pieces of fabric of the same design. The fell seam is made from a light green wool yarn in a 5 mm top stitch. It crosses in a right angle a 1 cm broad 3-5 mm wide top stitch hem. The junction is no longer preserved[69] (Fig. 11). The right angle is a clue to a dividing seam from a piece of clothing, like the ones on the kittle of the Celtic hunting god statue from Sarthe (France)[70] (Fig. 11). There are many other possibilities of what this fragment could have been a part of.

Hem meets Hem: find 73.340[71]

In 1846 a Hallstatt period wool fragment was excavated from the Kernverwässerungswerk (Plate 11/4, Fig. 12). It is a 6 by 10 cm broad textile find. The brown wool fragment has a 7 mm broad hem made out of a 3.5 mm wide top stitch that makes a right turn. It is a pity that the corner is frayed[72].

It is easier to interpret this find. It is possible to find such corners on blankets and on capes. Another possibility is a slit on the side of a top or neck cut-out. I have not found any representations showing such a construction in Iron Age art.

The practical nature of slits (Fig. 12) is that it enhances the manœuvrabilety which is required for physical work, so I would not exclude them from the list of possibilities of the Hallstatt period. If the slit at the neck cut-out is long enough it is also very practical for breastfeeding babies.

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[62] Inventarnummer Museum of Natural History Vienna. Compare Kurzynski, unpublished catalogue 1986-1991.

[63] Inventarnummer Museum of Natural History Vienna. Compare Hundt 1967: 46-48.

[64] Inventarnummer Museum of Natural History Vienna: 77.569. Compare Hundt 1987: 262.

[65] Inventarnummer Museum of Natural History Vienna: 75.989b. Compare Hundt 1967: 50-51. Fund 34 (nach Hundt) vgl. Hundt 1960: 139-141.

[66] Inventarnummer Museum of Natural History Vienna. Compare Hundt 1960: 132-133.

[67] Compare Hundt 1960: 146.

[68] Inventarnummer Museum of Natural History Vienna.

[69] Compare Hundt 1959: 82-85.

[70] Compare Cunliffe 1980: 66.

[71] Inventarnummer Museum of Natural History Vienna.

[72] Compare Hundt 1959: 78.

Rectangular patch

Another construction element is the use of rectangular patches of fabric. In two finds we can identify an inserted piece of rectangular fabric.
In 1992 the find 90.132[73] was excavated from the Kernverwässerungswerk mine (Plate 11/2 and Fig. 13a). It dates to the Hallstatt period. The textile sample is made up of two pieces of fabric of a different type. One is a tabby weave the other a panama weave. The two fabrics have different colours; the lighter fabric with the panama weave was set in at right angle. The edges were hemmed carefully. The seam was made with a light green yarn with a 3-5 mm top stitch.
In the year 1966 a similar find was made in the Kilbwerk mine: 75.955[74]. The patched piece was attached with a close top stitch in two colours. The stitch is only visible on one side of the fabric (Fig. 13b and Plate 9/2). The same care was taken when making the hem. It is made with a colourful stem stitch. Its exact whereabouts can no longer be identified.[75]
Both finds have similar decoration. The find from the Kilbwerk is special because of the seam with two colours, the other find special because of the different colours of the fabric and the difference in the weave. It is possible that such patches were used as decoration or constructional elements that were common in the traditional costumes of that period.

Sewn-on Braid: 89.832[76]

A spectacular find was made in 1990 in the Kernverwässerungswerk (Plate 7/5 and Fig. 14a). A 1.3 cm broad and 22 cm long tablet-woven braid was found. The Hallstatt period braid was sewn together at the end and sewn onto a twill fabric that has almost completely disintegrated. The braid has a complex design of meanders and filled triangles. It contains hair from a horse, used as the weft thread. A 0.5 mm thick yarn was used to join the ends of the braid together. The braid was sewn onto the twill with an olive green two-fold yarn[77].
The function of the braid could be as a border finish. It might have been used as decoration or as protection for the hem, maybe even both? It is also difficult to pinpoint the location of the braid; it could have been on the end of a trouser leg or a sleeve.
It is also possible to find braids in the art of that time. Pictures of braids can be found in Early Iron Age art. One example is from a sheath found in Hallstatt[78] (Fig. 14d). Another one is a statue from Idria[79] (Fig. 14c).

Sewn-on band: 90.182[80]

This find was made in 1993 in the Kernverwässerungswerk (Plate 5/2, Fig. 15a). The brown fabric has a chequered design on one side. The other side has a band that was sewn on with a paired yarn. The yarn was used to make a 3 mm wide top stitch.
Here the question arises as to what this band could have been used for. In view of the fact that the band is sewn onto the middle of the fabric it was not meant to reinforce the fabric which might be the case if it had been attached to the edge of a fabric to resist wear on the edges.
One possibility would be for a decorative purpose, even if the band is a bit irregular. The lines on the top of the celtic-hunting god[81] (Fig. 15b) could also be interpreted as a sewn on band. The leggings from the sheath[82] could be interpreted as sewn-on bands as well (Fig. 15d).
Another possibility is that a cord was inserted to pull the fabric together. On the Hallstatt textiles this cord was never found, but could still have been in such a good shape that it was removed and used elsewhere. A brooch from the Dürrnberg shows a figure with clothes[83] (Fig. 15c). The pants show folds that can be created by drawing together a cord under a band.

Sewn together out of multiple pieces: 73.347[84]

The biggest find made before 1901 is out of the Enderwerk. The Hallstatt period textile is 55 by 55 centimetres and is made up of 6 pieces. The parts 1, 2 and 3 are still in good shape. From the other pieces, only the seam is left. There are seams on all the edges, except for a 26 cm long piece that was used as the garment opening. The middle seam between one and two and the seam between five and one is made of a tubular edge; all the other seams are fell seams[85] (Plate 9/3, Fig. 16a).
There has not yet been an acceptable answer to the question, as to what its purpose could have been. In my opinion it could be a sleeve or a top with armholes. Another possibility could even be a hood like the one on a British statue[86] (Fig. 16b).

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[73] Inventarnummer Museum of Natural History Vienna.

[74] Inventarnummer Museum of Natural History Vienna.

[75] Compare Hundt 1967: 46-48.

[76] Inventarnummer Museum of Natural History Vienna.

[77] Compare Grömer 2001: 49-58. – Vgl. Kurzynski 1998: 40-41.

[78] Compare Ausstellungskatalog „Krieger und Salzherrn“, 1970: Tafel 78-81.

[79] Compare Cunliffe 1980: 16. – Kurzynski 1996: Abb. 41.

[80] Inventarnummer Museum of Natural History Vienna.

[81] Compare Cunliffe 1980: 66

[82] Comp. Ausstellungskat. „Krieger und Salzherrn“, 1970: Taf. 78-81.

[83] Compare Kurzynski 1996: 51.

[84] Inventarnummer Museum of Natural History Vienna.

[85] Compare Hundt 1960: 134-137.

[86] Compare Birkhan 1999.

[87] Compare Eibner 1997: 13, Abb. 4.

Using multiple pieces to create clothes seems to have been common in those days since we can find supporting illustrations on the Sopron vessels[87] (Fig. 16c).

Conclusion

The finds from Hallstatt give us an impression of the skills of the prehistoric tailor. It is possible to identify different kinds of seams, hems and stitches. The finds document the different methods used when making or repairing clothes.
Some finds show us that sewing together different elements was common. Based on the shapes of the preserved finds it is not possible to identify clearly whether textiles were sewn together for decorative purpose, whether the sewing had some kind of practical use or if it was just to enable a reuse of the fabric. Since there are no whole pieces of clothing, the surviving pieces make it difficult to identify clearly the shape and use of the fabrics.
A lot of small details show us that there was a wide variety of different clothing available at that time. There are different bonding types, patterns and colours. The different seams show us the wide scope of the designs available during that period.
Without consulting the art of that time, it is not possible to get an idea of what clothes then could have looked like. The small pieces left over do not give us enough clues to reconstruct traditional dress. Not a lot of art from the Bronze and Early Iron Age has survived and only a few items show us how clothes looked at that period. Fortunately these illustrations do show different types of clothing as well as demonstrating their similarities to the Hallstatt textiles.

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Dyestuff and element analysis on Textiles from the prehistoric Salt-mines of Hallstatt

Regina Hofmann-de Keijzer, Maarten R. van Bommel and Ineke Joosten

Abstract

Blue, yellow, green, olive-green, black, reddish brown and brown samples from sixteen textile fragments of the Hallstatt Period were investigated using high performance liquid chromatography with photo diode array detection (HPLC-PDA), scanning electron microscopy with energy-dispersive X-ray analysis (SEM-EDS) and various microscopic techniques. It was remarkable that in each sample, even in those which seem to be brown and black natural wool, at least one dyestuff was found. In total twenty-five dyestuffs, such as indigotin and indirubin, luteolin and apigenin, quercetin, ellagic acid and red dyestuffs originating from a dye insect and presumably from lichens were analysed. In the green, black and blue textiles combinations of dyestuffs were detected. The textiles contain the elements copper, iron and aluminium. In the article the origin of the dyestuffs and the elements will be discussed.

Blaue, gelbe, grüne, olivgrüne, schwarze, rötlichbraune und braune Proben von sechzehn hallstattzeitlichen Textilfragmenten wurden mit Hochleistungs-Flüssigkeitschromatographie mit Photo-Dioden-Array-Detektion (HPLC-PDA), Rasterelektronenmikroskopie mit energie-dispersiver Röntgenanalyse (REM-EDX) und verschiedenen mikroskopischen Techniken untersucht. Es war bemerkenswert, daß in jeder Probe, auch in jenen, die wie braune und schwarze naturfarbene Wolle aussahen, zumindest ein Farbstoff gefunden wurde. Insgesamt wurden 25 Farbstoffe analysiert, darunter Indigotin, Indirubin, Luteolin, Apigenin, Quercetin, Ellagsäure und rote Farbstoffe (aus einem Färbe-Insekt und vielleicht aus einer Flechte). In grünen, schwarzen und blauen Textilien wurden Kombinationen von Farbstoffen detektiert. Die Textilien enthalten die Elemente Kupfer, Eisen und Aluminium. Im Artikel wird die Herkunft der Farbstoffe und der Elemente diskutiert.

Introduction

Under the special conditions of the salt-mine organic materials as wood, leather, fur and textiles survived for more than 3.000 years. Since 1849 approximately 230 textile remains have been found in the Bronze Age and Hallstatt Period salt-mines. Most of the textile fragments consist of wool; only two fabrics of the Bronze Age were made of flax or hemp. More than 140 woollen textile remains belong to the Hallstatt Period (800-400 BC)[1]. Due to the impregnation by salt, the constant climate of the mine and the fact that the textiles were protected from light for more than 2.000 years these textiles including their colours are in a relatively good condition. The colours vary from yellow to olive-green, green, brown, reddish brown, greenish blue, blue and black.

In the year 2002 a multidisciplinary research project, called Halltex 1, started with the investigation of the coloured textiles from the prehistoric mine of Hallstatt in Austria. This pilot project was a collaboration between the Prehistoric Department of the Natural History Museum Vienna, the Research Department of the Netherlands Institute for Cultural Heritage (Instituut Collectie Nederland – ICN) in Amsterdam and the Department of Archaeometry of the University of Applied Arts Vienna.

The aim of the project Halltex 1 was to investigate if the woollen textile fragments were dyed and if so, which dyes and dyeing techniques were used. It was of interest to analyse the elements which affect the colour, whether they were used as mordants or came into fibres while the textiles laid embedded in the "heathen's rock" (*Heidengebirge*)[2]. Further the condition of the fibres was observed. A literature study about dyeing in the Iron Age was carried out to put the results into a wider context.

Dyes and dyeing in the Iron Age

As written sources are unknown in prehistoric times, our knowledge about dyeing techniques used is based on the dyestuff analysis of archaeological textiles and on finds of dye plants and dyes. Additionally dyeing experiments are performed to obtain knowledge about dyeing at that time.

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[1] See Reschreiter, in this volume and Grömer, in this volume.

[2] Explanation see Reschreiter, in this volume.

Dyestuff analysis

Many analytical methods are available for the identification of natural dyestuffs; a microchemical test for indigotin, chromatographic methods, such as thin-layer chromatography (TLC) and high performance liquid chromatography (HPLC) mostly coupled with spectroscopic techniques[3].

During dyeing each dye leaves a fingerprint on the textile, consisting of a combination of different dyestuffs, main compounds and minor compounds. Only dyes with a characteristic fingerprint can be identified, as in the case of red dyes of the Rubiaceae family (e.g. madder and *Galium* species), insect dyes and several yellow dyes. The source of indigotin and tannins cannot be determined. Only if a dye is identified can the result tell us something about the history of the textile. Of course one needs to know the history of this dye, in which region and in which period it was used.

Compared to the number of dyestuff analyses performed on textiles of much later periods only few prehistoric textiles have been analysed. We owe most of the knowledge to Walton Rogers, who analysed the dyestuffs of Iron Age textiles using UV/Visible absorption spectrophotometry and thin-layer chromatography (TLC)[4]. Therefore the early history of dyeing in Europe is far from clear and a good deal of what has been written on this subject concerns just possibilities, as for instance dyeing in Neolithic times[5]. Late Bronze and Early Iron Age textiles made from both wool and linen show green, red, blue, brown, black and possibly yellow dyes[6]. Yet until now it has been thought that the Iron Age textiles from Hallstatt were mainly in natural wool colours and that only a few were dyed[7]. The Hohmichele textiles and textile fragments from Norway and Denmark showed a similarly limited application of dyestuffs, while in most of the Hochdorf textiles dyes were detected, such as kermes, unknown reds and tannins[8]. Based on her experiences Walton Rogers considers that where no dyestuff is detected, a dyestuff might have decayed beyond detection[9].

Dyeing methods

Principally three different sorts of organic colorants (pigments, dyestuffs and tannins) and three different dyeing techniques could have been used for dyeing textiles in the Iron Age. With indigotin, a non-soluble organic pigment e.g. gained from woad, textiles could be dyed blue using the method of vat dyeing. Most of the water-soluble red dyestuffs (anthraquinones of madder and insect dyes) and yellow dyestuffs (flavonoids of weld and dyer's broom) are mordant dyestuffs which in modern technology could also be called "metal complex dyestuffs"[10].

Co-ordination metals of metal salts (e.g. mordants containing aluminium, iron or copper) are able to form a chemical bond between dyestuffs and fibres producing a stable dyeing on a textile. Most mordant dyes yield different colours with different mordants. Among the water-soluble substantive dyestuffs, which bind directly to the fibres, tannins and naphthoquinones, derived from black walnut shells, could have been used for brown shades and lichen dyes for red shades.

Vat dyestuffs are suitable to dye protein fibres (wool and silk) as well as cellulose fibres (linen, hemp and cotton); mordant dyestuffs bind better to protein fibres and direct dyestuffs are more suitable for cellulose fibres[11].

Blue dyes

The leaves of a number of indigo plants contain a precursor of indigotin, a blue pigment. Indigo, originating from subtropical and tropical Indigofera species, was used in the Indus Culture (Mohenjo-Daro, 2.300-1.700 BC)[12] and probably in the Pharaonic Egypt[13] but its use seems to have been only of slight importance to the Romans[14].

Leaves of woad (*Isatis tinctoria* L.) have a precursor different from that of the indigo shrub. But the different precursors lead to the same colorant indigotin. The natural distribution of woad is from South East Europe to Central Asia. Yet already in prehistoric times woad seems to have been widespread in Europe. It has been found in a Neolithic cave in France (de l'Adouste near Joursque, Bouches du Rhône)[15]. Five seed impressions of woad were found on pottery of the Iron Age (Hallstatt, 6th and 5th century BC) at Heuneburg, southern Germany and woad fruits have been found in an Iron Age pot at Ginderup, Denmark and in Iron Age (1st and 2nd centuries AD) deposits on the north-west coast of Germany and parts of woad were found in Eberdingen-Hochdorf (Early La Tène Period)[16]. The discovery of woad in Iron Age Dragonby (first centuries BC and AD) demonstrates that it was definitely available in Britain at the time of the Roman conquest, while before it only was known that Caesar (De Bello Gallico, Book V, 14) reported its use as a body paint by the ancient Britons[17]. Pliny mentions the use in Gaul (Nat. Hist. XXII 2-3)[18].

Although the source of indigotin cannot be determined by chemical analysis it is most likely that in Iron Age Europe woad was used for dyeing blue and not indigo. In Tab. 6 it is shown that indigotin has been identified frequently in Iron Age textiles. In a woad vat the insoluble indigotin is transformed by fermentation into a yellowish substance which is soluble in water, the so-called leuco-indigotin. The textile is then dipped into the vat, where the leuco-indigotin is absorbed by the fibres. When the textile is taken out of the vat, the leuco-indigotin comes in contact with the oxygen of the air and is oxidized into indigotin and the textile is dyed blue. If vat dyeing is combined with mordant dyeing one can dye green and violet (Plate 12/1).

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[3] Hofenk de Graaff 2004: 23-24.

[4] Walton 1988. – Walton Rogers 1999 and 2001.

[5] Walton Rogers 1999: 244-245. – Barber 1992: 223-224.

[6] Barber 1992: 224.

[7] Hundt 1987: 277. – Ryder 1990. – Walton Rogers 1999: 245.

[8] Bender Jørgensen and Walton 1986: 179. – Walton 1988: 146. – Walton Rogers 1999: 245.

[9] Walton Rogers 1999: 241.

[10] Hofenk de Graaff 2004: 14-18.

[11] Hofenk de Graaff 2004: 14-15.

[12] Böhmer 2002: 217.

[13] Germer 1985: 74-75.

[14] Forbes 1964: 111-112.

[15] Banck-Burgess 1998: 30. – Banck-Burgess 1999: 86.

[16] Bender Jørgensen and Walton 1986: 185. – Hall 1995: 33. – Hall 1996: 638. – Banck-Burgess 1999: 86.

[17] Van der Veen, Hall and May 1993: 367, 370.

[18] Bender Jørgensen and Walton 1986: 185.

Mordants

In the Iron Age different sources of metal salts were available. It is not known if alum, $Al_2(SO_4)_3 \cdot K_2SO_4 \cdot 24H_2O$, the most important mordant or other inorganic aluminium sources were available for dyeing in Iron Age Europe. By the use of natural acidic substances such as vinegar one could have produced corrosion products (metal salts) on bronze, copper and iron objects and applied them as mordants. Further iron(III)-containing mud from mires could have been used as well. Plants of the clubmoss family accumulate aluminium in their tissues. In a much later period (9th-11th century AD, Coppergate, York) *Diphasium complanatum* (L.) Rothm. which was found together with madder (*Rubia tinctorum* L.) and dyer's greenweed (dyer's broom, *Genista tinctoria* L.) was probably brought from the Viking's homelands in Scandinavia as a mordant to Britain[19]. In Plate 12/1 it is shown how iron salts and copper salts affect the colours of mordant dyes.

Red dyes

Since ancient times roots of the plant family Rubiaceae containing anthraquinones were used world-wide for dyeing red. Roots of madder (*Rubia tinctorum* L.) contain the dyestuffs alizarin and purpurin and were used as a dye by the Egyptians, the Greeks and the Romans. The plant is indigenous to Asia Minor and Central Asia. It was widely cultivated in several places in the Roman Empire, e.g. in Italy and Gaul[20]. Yet it seems that the cultivation of the plant in other parts of Europe did not start before the Early Middle Ages [21]. Madder was found on a textile from the Roman Iron Age Period in Norway. Since madder has only been found in rich graves, it seems likely that the ready-dyed textiles or garments were being brought from abroad or that the dye was imported for use in the best quality textiles[22]. Madder could be used for dyeing red and, top-dyed with woad or indigo for dyeing violet; if red-dyed wool is post-mordanted with iron or copper salts, one obtains dark red and violet colours (Plate 12/1).

The roots of the *Galium* species, also belonging to the Rubiaceae, contain anthraquinones different from those of madder[23]. As they were growing naturally in Europe they could have been used as dyes in prehistoric times. On some Iron Age textiles from less wealthy sites of Denmark a 'madder type' dyeing was found, in which no alizarin was present which according to Walton points to the *Galium* species[24].

Another source for red dyestuffs is insects. In ancient Eurasia four insect dyes were known: kermes, Polish cochineal, Armenian cochineal and lac[25]. Due to the fact that each of these dyes contains a characteristic anthraquinone fingerprint they can be identified on textiles. Kermes (*Kermes vermilio* (Planch.) Targ) lives on the kermes oak (*Quercus coccifera* L.) which is native to the Mediterranean region. Kermes has been used for dyeing since antiquity. When kermes was identified on locally produced Iron Age textiles at Hochdorf there was a discussion about whether the dye was imported or arrived as ready-dyed cloth, which may have been unpicked and the yarn re-used[26]. Polish cochineal (*Porphyrophora polonica* L.) was collected south of the Baltic See, where it lives on roots of *Scleranthus perennis* L. For a red colour of one good quality Norwegian Iron Age textile the identification of Polish cochineal seems safe[27]. Armenian cochineal (*Porphyrophora hameli* Brandt) is native to the area of Mount Ararat and is a parasite on the roots of two grass types. Lac, together with uncoloured shellac, can be produced from a resin-like material which is secreted by lac insects (*Kerria lacca* Kerr.) living on trees in India and Southeast Asia. With the exception of lac, of which the habitat is presumably too far away, such insect dyes could have been traded in Iron Age Europe.

Beside the *Galium* species, there was another local source available for red, namely orchil, made from lichens. So far, however, it has not been identified in a prehistoric European textile. In Tab. 6 the red dyes found in Iron Age textiles in Europe are summarized.

Yellow Dyes

For dyeing yellow, nature provides a lot of flavonoid dyes. Weld (*Reseda luteola* L.), the most important yellow dye of ancient times is native to South Europe and Western Asia and contains luteolin as the main component and apigenin as a minor component. Seeds have been found in Neolithic and Celtic Central Europe[28]. Dyer's broom (*Genista tinctoria* L.), another yellow dye, growing in Europe and Asia could have been used in prehistoric times. It contains the same main component as weld, namely luteolin, and genistein as a minor component. The yellow dyes

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[19] Kenward and Hall 1995: 771-772. – Hall 1995: 35. – Hall 1996: 636-638.

[20] Bender Jørgensen and Walton 1986: 185, Walton 1988: 154-155.

[21] Ploss 1989: 8. – Kurzynski 1996: 43. – Hofenk de Graaff 2004: 94.

[22] Walton 1988: 154-155.

[23] Hofenk de Graaff 2004: 124-129.

[24] Walton 1988: 155.

[25] Böhmer 2002: 203-214. – Hofenk de Graaff 2004: 52-91.

[26] Banck-Burgess 1996: 63. – Banck-Burgess 1998: 31. – Walton Rogers 1999: 244.

[27] Walton 1988: 156.

[28] Kurzynski 1996: 42.

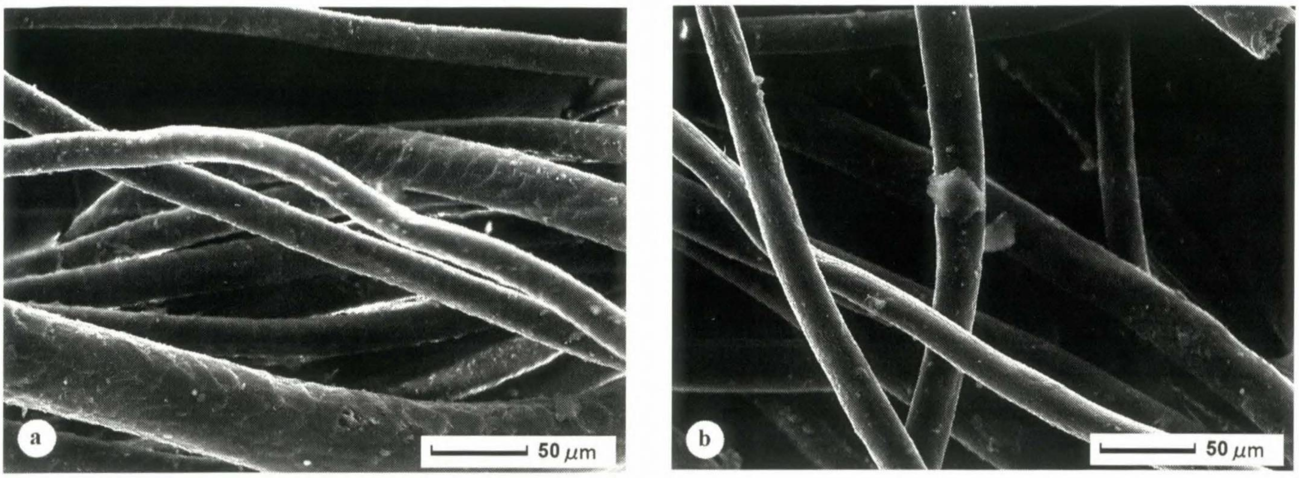

Fig. 1: Hallstatt textiles, fibre-analysis: surface of the wool fibres monitored with SEM. 1a: fibres with scales, green sample 89725. – 1b: fibres without scales, yellowish brown sample 81160 (© ICN).

found in Iron Age textiles are listed in Tab. 6. If an aluminium-containing mordant such as alum is used the yellow shade is not affected. Yellow top-dyed with woad or indigo gives green as a result. If flavonoids are mordanted with iron salts, brownish and olive-green colours are obtained; if they are mordanted with copper salts, the resulting colours are olive-green and olive-brown (Plate 12/1).

Brown and black dyes

Since ancient times water-soluble tannins have been used for tanning leather and for dyeing (Tab. 6). A lot of plants, especially barks, contain tannins which bind directly to the fibres giving brown colours and iron-gall black if they are used together with iron-rich material (Plate 12/1).

Scientific investigation of the Hallstatt textiles

Samples were taken from each of the characteristic shades found on the textiles of Hallstatt, altogether 17 samples from 16 textiles. Relatively large samples were taken, 2 to 3 cm long, depending on the thickness of the thread, in order to find out what the possibilities and limitations of the analytical techniques are, when they are applied to prehistoric textiles. For the scientific investigation of the Hallstatt textiles a database was developed using Microsoft® Access 97, which was combined with the photo documentation system of the prehistoric department of the Natural History Museum Vienna.

Microscopic observation

Prior to dyestuff analysis, all samples were investigated under an optical microscope by incident and transmitted light (magnification 20-600x). These techniques were used to identify the fibres, to observe the condition of the fibres and the regularity of the colour within the yarns and the fibres. Microscope photos were taken and added to the Access database.

SEM-EDS analysis

Scanning electron microscopy was performed with apparatus equipped with an energy-dispersive X-ray spectrometer system (SEM-EDS). SEM enables a much larger magnification than is possible with an optical microscope (magnification up to 30.000 times). At higher magnification fibre analysis and the investigation of the deterioration and contamination of the fibres can be examined in more detail. The EDS was used for elemental analysis of the fibres to study the presence of mordants and to investigate if the samples were contaminated with elements originating from the mine. Analytical details of these techniques are given in the appendix.

HPLC analysis

Dyestuff analysis was performed with high performance liquid chromatography coupled to photo diode array detection (HPLC-PDA) according to ICN standard operation procedure (SOP) no. 36[29], which is derived from Wouters and Rosario-Chiniros[30]. Prior to HPLC analysis, the dyestuffs are extracted from the textile fibre in order to get them into solution. This extraction is done with hydrochloric acid and is destructive to the sample. After the colorants are separated on an analytical column they are identified by the retention time and by comparison of the UV-VIS absorption spectra with data of known reference materials, stored in an HPLC library. The retention time is the time needed for a component to elute from the analytical column and depends on the chromatographic behaviour of the compound.

In the HPLC library at the ICN, reference spectra of the most common natural dyestuffs are available. Unfortunately, identification is not always possible, due to the low concentration in a sample or the lack of reference material. However, if chemical identification is not possible, at least

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[29] Standard Operation Procedure no. 36, 1997: 1-8.

[30] Wouters and Rosario-Chiniros 1992: 237-255.

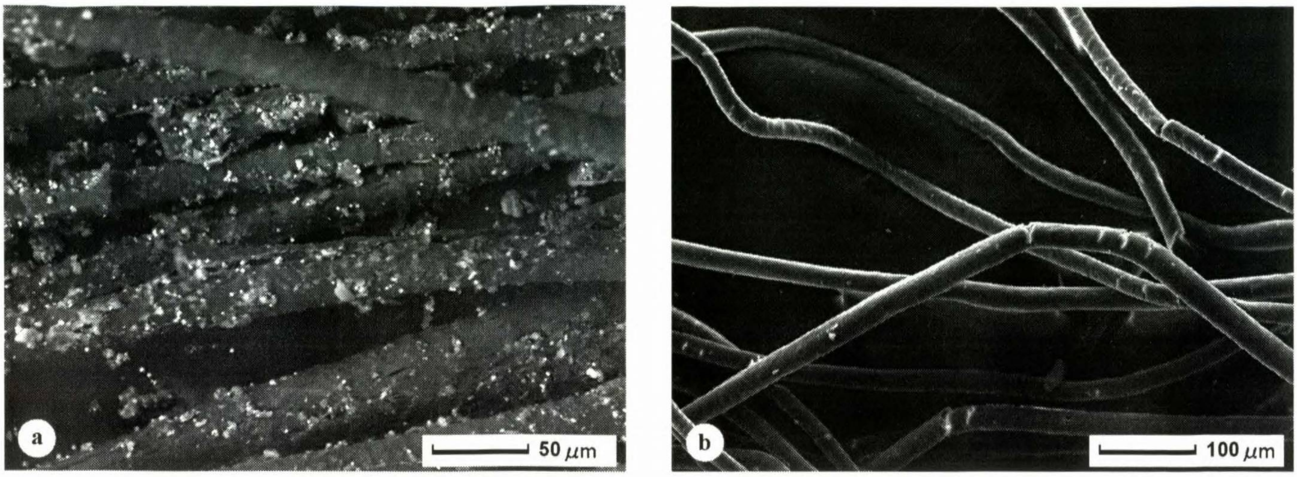

Fig. 2: Hallstatt textiles, fibre-analysis: contamination and degradation of wool fibres monitored with SEM. 2a: heavily soiled fibres, olive-green sample, 75815. – 2b: fibres with tears and without scales, reddish brown sample 89835 (© ICN).

the colour of the unknown dyestuff can be deduced from the UV-VIS absorption spectrum unless it is a degradation product, which has undergone a change of colour. Analytical details of the technique are given in the appendix.

Results and discussion

Analysis of the fibres

With the use of optical microscopy, it was confirmed that all samples consist of wool, which is consistent with previous results[31]. When SEM was applied, it was observed that scales were visible but in most of the samples the scales were degraded. This is shown in Fig. 1a and 1b. The surface of nearly all samples was contaminated with several inorganic particles. Yet some samples were strongly soiled as is shown in Fig. 2a. In addition, tearing of the fibres has been found in samples where scales have completely disappeared (Fig. 2b).

The degradation of the scales and the tearing of the fibres seem to be correlated to the concentration of copper and the combination of iron and tannins. The degradation of the fibres could have taken place at different times, during the wearing of the textiles and their secondary use in the mine, during the time they were deposited in the mine and after they were excavated.

Analysis of the chemical elements

For elemental analysis, first energy-dispersive X-ray fluorescence spectrometry (XRF) was performed, since this is a very fast technique, and non-destructive to the object. It turned out that this method, frequently used for the identification of mordants, was not suitable for the investigation of the Hallstatt textiles, because under the microscope it was observed that many fibres are contaminated with different sorts of particles. As the sample spot is 2 x 3 mm, XRF detects not only the elements of the textile fibres but also the elements of these contaminating particles.

SEM-EDS was performed, therefore, to analyse small areas of a single fibre, which were free of particles. The particles themselves were analysed separately for comparison. The disadvantage of performing the SEM-EDS analysis on a small area, about 30 x 30 µm of a textile fibre, is that the overall response is rather low. Even the detection of the mordant of reference textiles, with a high concentration of mordant, is sometimes not possible if only a small area of a single fibre is analysed.

Using SEM-EDS several elements were detected. Three elements, i.e. sulphur, oxygen and carbon, were detected in large quantities. They are part of the wool protein. Most of the samples contained calcium, copper, iron, aluminium and silicon. In some samples potassium, chlorine, magnesium, phosphorus and titanium were found. For dyeing purposes, however, only elements which could be used as mordants are of interest, so the research was focussed on aluminium, copper and iron.

Aluminium was found in six samples (Tab. 1-4). Because it was always identified together with silicon, which certainly originates from the minerals of the mine, it is most likely that the aluminium found is a contaminant. It could not therefore be proved that an aluminium-containing mordant was used.

Copper was found in fourteen samples, sometimes in higher concentrations (Tab. 1-4). It is not known if the copper in the fibres originated from a copper-baring mordant or from the salt-mine. As no copper is found in the salt-mine itself, the only external source of copper is the broken-off tips of bronze picks of the Hallstatt Period (Plate 12/2-3). Fragments ofur and textiles whjich were situated in areas close to these copper sources are contaminated with copper as is shown in Plate 12/4-5.

Iron was found in ten samples (Tab. 1-4). As iron-containing layers containing iron are found in the salt-mines at Hallstatt, the iron might originate from the mine or from a mordant. However, it was striking, that in both black texti-

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[31] Ryder 1990 and 2001.

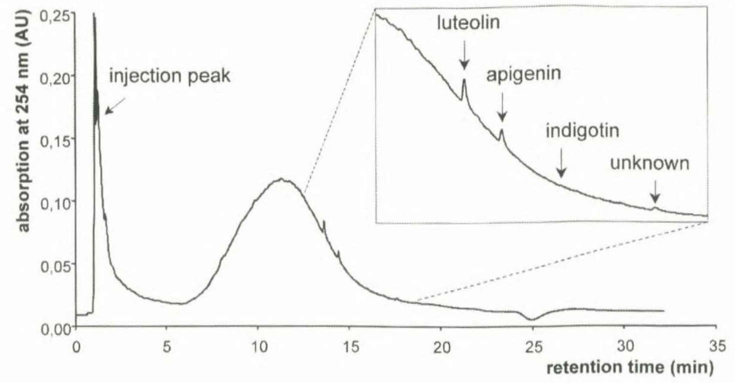

Fig. 3: Hallstatt textiles, dyestuff-analysis: HPLC chromatogram of light brown sample 75977#1. Luteolin, apigenin, indigotin and an unknown red dyestuff were detected (© ICN).

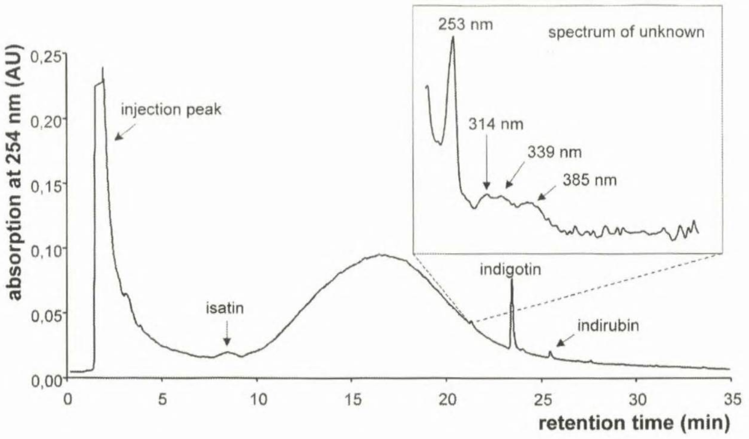

Fig. 4: Hallstatt textiles, dyestuff-analysis: HPLC chromatogram of blue sample 78526 and spectrum of unidentified yellow component (© ICN).

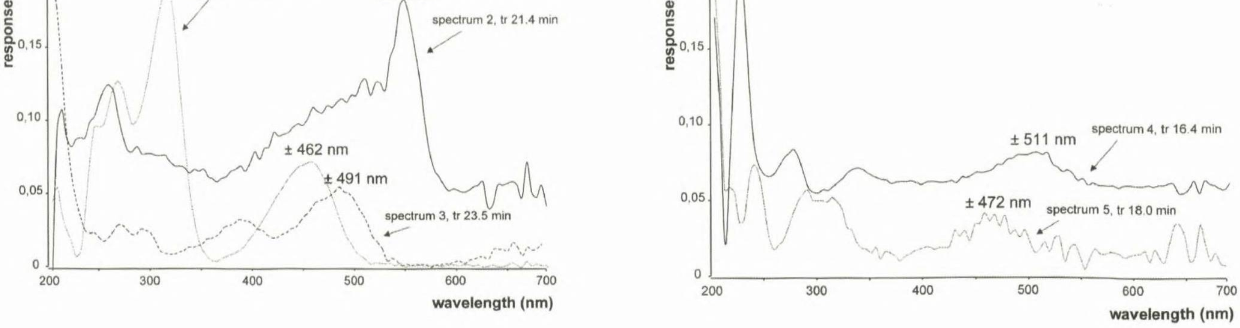

Fig. 5: Hallstatt textiles, dyestuff-analysis: HPLC spectra of red colorants detected. 5a: spectrum 1: probably carminic acid, spectrum 2: probably orcein, shows fluorescence as well, spectrum 3: kermesic acid. – 5b: spectra of unidentified red components (© ICN).

les (88892 and 89893) iron was found and no copper. With dyestuff analysis an ellagic acid equivalent was identified, which indicates the use of tannins. As iron, in combination with tannins, can be used to dye iron gall black, in the case of the black textiles it is likely that an iron-bearing mordant was used.

Although small areas without contaminating particles were analysed with SEM-EDS, elements originating from the mine were found. The general conclusion, therefore, from the elemental analysis is that it is not possible at this stage to distinguish between elements originating from the mine and from the mordant.

One has to realise that not only elements from the mordants but also from the mine can affect the final colour. Iron and copper salts cause colouration of the wool fibre, even when no dyes are present. Mordants containing iron and copper can be used after the dyeing process to achieve different darker shades. The same 'post-mordanting' effect could have happened accidentally in the mine. Under the influence of copper and iron ions red shades dyed with anthraquinones become darker showing violet or brown nuances. Yellow shades dyed with flavonoids are changed into yellowish green and olive-green when copper ions are present and they are changed into olive-brown and brown when iron ions are present. While copper ions do not influence a tannin dye, brown shades dyed with tannins turn into black when they come in contact with ions of iron (Plate 12/1).

Analysis of the dyestuffs

In general, the response of the dyestuffs was extremely low and a much disturbed baseline was observed in all samples. A typical chromatogram is presented in Fig. 3. This baseline disturbance probably has to do with the fact that after the acid hydrolysis, the degraded wool was partly dissolved as well. This is often seen when fragile archaeological textiles are analysed. Only by a proper magnification of the chromatogram were dyestuffs detected.

The results of the HPLC analysis and the conclusions are given in Tab. 1 to 4. In most samples, dyestuffs could be identified and the name of the colorants found is listed in the tables. However, numerous compounds could not be identified due to the low response, resulting in poor spectra. As a result, the spectra do not match with the spectra of reference material. In that case, the retention time (Tr, in minutes) and the absorbance in the visual range (abs, in absorption units, AU) is given and, if possible, the name of the most likely compound is given, for instance "probably kermesic acid" (see sample 79422 in Tab. 1). In some other cases, colorants were found with the spectra resembling those of dyestuffs of reference material but eluted at a different retention time. In that case, the compound is labelled as "equivalent", such as in sample 77776c (Tab. 1) where an ellagic acid equivalent was found.

Identification of dyes is hampered by the fact that there is less experience concerning the HPLC-PDA fingerprints of dyes used in the Hallstatt Period. Furthermore, dyestuffs can be degraded due to the conditions in the mine. At the present moment there is no knowledge about these degradation mechanisms. In addition, one has to be aware that textiles as well as dyes could be traded and local dyes could have been used as well. A lot of different dyes therefore could have been used.

Greenish blue and blue textiles

Blue textile fragments are presented in Plate 13/1 und 7/4. With HPLC-PDA up to ten different compounds were identified in the greenish blue (77776 and 79442a) and blue samples (78526 and 89845): indigotin, indirubin, indirubin equivalent, isatin, quercetin, three different red compounds, yellow compounds and an ellagic acid equivalent. The results are presented in Tab. 1.

In all samples, indigotin was analysed in a high concentration together with its isomer indirubin and isatin, a degradation product of indigotin. Unfortunately, the source of indigotin cannot be determined by chemical analysis. Indigotin may originate from any indigo plant. Yet in prehistoric Europe woad is the most likely to have been used for dyeing blue. Woad was the only indigotin-bearing dye which was widespread across Europe at that time.

Walton Rogers already identified indigotin in three of these blue samples (77776, 78526 and 79442) by using UV/visible absorption spectrophotometry[32]. In a greenish blue textile (79442a) and a blue textile (89845a) an unidentified yellow compound with absorption maxima at 338 and 385 nm was found; the spectrum is represented in Fig. 4. The same compound, together with indigotin, was identified in textiles of Late Antiquity[33]. This yellow compound could originate from woad or might be a degradation product of indigotin. Further research has to be carried out to determine the origin of this compound.

In all samples the flavonoid quercetin was analysed, in three of them alongside an ellagic acid equivalent. Quercetin is one of the most widespread flavonoids, and there are many tannin plants which might be the source of ellagic acid. It could be that both components originate from the same plant. There are several plants in which the combination of ellagic acid and quercetin is found such as Sweet gale (*Myrica gale* L.), Bearberry (*Arctostaphylos uva-ursi* (L.) Spreng.), myrtle-leaved coriaria or Currier's sumach (*Coriaria myrtifolia* L.) and several Sumac species (*Rhus* L.)[34]. Due to lack of other specific compounds the dye plant could not be identified. Another possibility is that quercetin originates from woad in which it is said to be as a minor component together with kaempferol[35]. It could have been bound to the fibre by a Hallstatt vat dyeing technique so far unknown.

In one greenish blue textile (79442a, Plate 7/4) and a blue textile (89845a, Plate 13/1) kermesic acid was detected (Fig. 5a). If only kermesic acid is found we can conclude that kermes had been used for dyeing. Besides kermesic

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[32] Walton Rogers 2001: 243 and 245.

[33] Hofmann-de Keijzer and Van Bommel, DHA 21, to be published.

[34] Schweppe 1992: 387, 476-479, 480.

[35] Schweppe 1992: 295.

Sample, Colour	Elements	Dyestuffs	Dyes
78526 Blue	Cu	Indigotin, indirubin, isatin Yellow component, tr 22.34 abs 339 & 385 nm, might be related to woad	Woad
		Quercetin	Unknown yellow dye
		Probably carminic acid, tr 16.90 abs 472 nm	Insect dye ?
		Ellagic acid equivalent, tr 18.63 abs 361 nm	Tannins
89845a Blue	-	Indigotin, indirubin, isatin Yellow component, tr 22.67 abs 339 & 385 nm, might be related to woad	Woad
		Quercetin Unknown yellow compound, tr 25.26 abs 333 & 350 nm	Unknown yellow dye
		Probably carminic acid, tr 16.94 abs 462 nm Kermesic acid, tr 23.64 abs 491.8 nm	Insect dye
		Probably orcein, tr 21.4 abs 555nm	Probably orchil
		Ellagic acid equivalent, tr 18.56 abs 361 nm	Tannins
77776c Greenish blue	Cu	Indigotin, indirubin, isatin	Woad
		Quercetin	Unknown yellow dye
		Ellagic acid equivalent, tr 18.26 abs 361 nm	Tannins
79442 Greenish blue	Cu and traces of Fe	Indigotin, indirubin, indirubin equivalent, isatin Yellow component, tr 22.46 abs 339 & 385 nm, might be related to woad	Woad
		Quercetin Unknown flavonoid, tr 18.37 abs 357 nm	Unknown yellow dye
		Probably carminic acid, tr 16.72 abs 457 nm Kermesic acid, tr 23.43 abs 491.8 nm	Insect dye

Tab. 1: Hallstatt textiles, dyestuff-analysis: results of SEM-EDS analysis and HPLC analysis of the blue and greenish blue textiles (© ICN / University of Applied Arts Vienna, Dept. Archaeometry).

acid, another red dyestuff was found, the retention time of which corresponds with that of carminic acid (Fig. 5a). Unfortunately, the response was very low and the spectrum obtained was not well-developed. As a consequence, identification was hampered. However, based on the retention time and the fact that it was a red dye, carminic acid is most likely. It is possible therefore that for these textiles another dye-insect was used and this may have been Polish cochineal. Polish cochineal can be identified with HPLC when approximately 60–90 % carminic acid and 40–10 % kermesic acid is present[36]. In the samples of the Hallstatt textiles, the amount of carminic acid was lower than that of kermesic acid. The ratio between carminic acid and kermesic acid differs from the ratios usually detected in Polish cochineal, Armenian cochineal or kermes[37]. Exact identification of the dye source, therefore, was not possible. It could be possible that carminic acid is degraded due to the conditions in the mine. When carminic acid loses its glucose unit, kermesic acid remains. Yet, it is unknown if this process happens in the mine. It could also be that a mixture of Polish or Armenian cochineal with kermes was applied or another, unknown, dye insect.

Since these insects are not native in the Hallstatt area, the dye or the dyed textiles must have been imported to Hallstatt. Polish cochineal originates from Northeast Europe, Armenian cochineal from Western Asia whereas kermes is native to the Mediterranean area[38].

In addition, a red component was found in the blue sample (89845a) which is probably orcein (Fig. 5a) and points to orchil. Although lichens were available in Europe for producing orchil, this dye has not yet been identified in any European prehistoric textile.

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[36] Wouters and Verhecken 1989: 393-410.

[37] Wouters and Rosario-Chiniros 1992: 237-255.

[38] Böhmer 2002: 203.

Sample, Colour	Elements	Dyestuffs	Dyes
77334a Yellow	Traces of Cu	Luteolin Apigenin	Likely weld
89725 Green	Cu and traces of Fe, Al & Si	Indigotin Luteolin Apigenin	Woad Likely weld
75815 Olive-green	Cu and traces of Fe, Al & Si	Luteolin Apigenin	Likely weld
90129 Olive-green	Cu and traces of Al & Si	Indigotin (low response)	Woad

Tab. 2: Hallstatt textiles, dyestuff-analysis: results of SEM-EDS analysis and HPLC analysis of the yellow, green and olive-green textiles (© ICN / University of Applied Arts Vienna, Dept. Archaeometry).

Microscopic investigation of the samples of the greenish blue and blue textiles showed that the fibres of the greenish blue sample (79442a) were dyed regularly whereas in the other samples parts of the fibres, lying in the centre of the yarn, were light blue or nearly colourless. This means that tightly twisted yarns were dyed and, as a result, the colorant did not penetrate completely into the textile fibre. This indicates that in the Hallstatt Period yarn was dyed and not just loose wool. There is also evidence that fabrics were dyed as well[39].

White wool was used for all greenish blue and blue textiles[40]. It is an interesting result that the greenish blue as well as the blue shades turned out not to be pure indigotin-dyeing. The method of dyeing a deep blue-black using tannin on woad, already found on textiles from Eberdingen-Hochdorf[41], was also known by the dyers of the Hallstatt textiles. Yet, for producing the blue shades of the Hallstatt textiles, beside tannins, red and yellow dyestuffs were also used. The combination of all these dyes may have created deep dark greenish blue or reddish blue shades. It is possible that due to degradation of dyestuffs the textiles originally had a different shade. At this stage, however, nothing is known about the degradation processes of dyestuffs in salt-mines.

Yellow textile

The textile 77334a has a bright yellow colour, which is presented in Plate 13/3. With HPLC-PDA only the yellow dyestuffs luteolin and apigenin were found in this textile (Tab. 2). If luteolin and apigenin are found together in a textile one normally concludes that weld (*Reseda luteola* L.) has been used. Analysis of reference samples dyed with weld indicates that luteolin is usually present in abundance. In the samples from Hallstatt, the amounts of luteolin and apigenin are equal, so the situation is different from that normally found in weld dyeings. This may be due to three causes. Luteolin possibly degrades faster than apigenin under the conditions in the mine. It could also be that weld at that time contained a different concentration of luteolin and apigenin or another plant was used, which also contains these dyestuffs but in a different ratio. Luteolin and apigenin for instance occur in Dyer's Chamomile (*Anthemis tinctoria* L.), in Roman Chamomile (*Chamaemelum nobile* (L.) All.), in German Chamomile (*Matricaria chamomilla* L.) and in Yarrow (*Achillea millefolium* L.)[42].

Green and olive-green textiles

In the green (89725) and the olive-green samples (75815, 90129) luteolin, apigenin and indigotin were detected. The results are presented in Tab. 2. There are no stable green natural dyestuffs and therefore green was obtained by dyeing blue in a leuco-indigotin vat followed by dyeing yellow using a mordant dyestuff. This combination was only observed in the green textile (89725, Plate 8/3) in which indigotin, luteolin and apigenin were identified. Copper ions were also found which influence the green colour, yet it is not clear if copper was used during the dyeing process or came into the textile while it was buried in the mine.

There are many olive-green textiles found in the Hallstatt region; during this project two olive-green samples were analysed.

In the olive-green sample from fragment 75815, presented in Plate 13/4 the dyestuffs luteolin and apigenin were found together with a higher amount of copper. The combination of luteolin and apigenin probably indicates the use of weld. The use of an indigotin dye can be excluded, because the HPLC system for indigotin is very sensitive and no indigotin was identified. The olive-green colour, therefore, is presumably caused by the influence of copper ions on a yellow dyeing produced with the flavonoids luteolin and apigenin. The dyestuffs themselves indicate a yellow colour. An olive-green colour could be obtained when copper was used as a mordant or by contamination with copper from the mine. It is therefore not possible to determine the original colour.

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[39] Grömer in this volume.

[40] Ryder 2001: 230-232.

[41] Walton Rogers 1999: 243-245.

[42] Schweppe 1992: 349-353. – Böhmer 2002: 136.

In the olive-green sample 90129 only a trace of indigotin was found. So the green colour is probably caused by the high amount of copper in the textile. Because only a small amount of indigotin was found, it is possible that the concentration of the yellow dyestuffs was below the detection limit. Yet, if only vat dyeing had been carried out, no mordant would be necessary and it could be concluded that the copper originates from the mine and the original colour of the textile was blue.

In the 1950's a discussion about the origin of the typical olive-green of the Hallstatt textiles arose. Hundt suggests that a method similar to that of an old, traditional Swedish recipe was used[43]. First the wool is dyed yellow with heather or dyer's broom. Then the wool is treated with water heated in an iron cauldron where through the influence of iron the yellow turned into olive-green grey. After analyzing one olive-green and one brown textile Specht was convinced that the colour is only caused by copper and iron salts originating from the prehistoric mine[44]. According to Barber the uniformity of colour throughout the piece and the fact, that the colour is so nearly the same colour as a number of other Hallstatt textiles make purposeful dyeing more likely[45].

On the basis of the results obtained by this research it is not possible to draw accurate conclusions. In the olive-green samples, copper probably has an effect on the final colour but it is unknown whether it was applied as a mordant or originates from the mine. Surprisingly, in the two olive-green samples analysed no iron was found.

Black textiles

A black textile fragment is presented in Plate 13/2. In the black samples (88892, 89893) up to five different dyestuffs were identified using HPLC-PDA. The results are presented in Tab. 3. An ellagic acid equivalent and indigotin in a relatively high amount were detected in both of the samples.

In addition, in sample 88892 probably luteolin, probably apigenin and three unknown yellow components were found. As the concentration of the yellow colorants was very low, the spectra were not well-developed and interpretation was difficult. Based on retention time, luteolin and apigenin are likely, indicating the use of weld (*Reseda luteola* L.) or other luteolin and apigenin containing plants, such as were discussed in reviewing the yellow sample above.

In addition to ellagic acid and indigotin, an indirubin equivalent and a high amount of an unknown red dyestuff were found in the black sample 89893. Although the red component elutes at a retention time comparable with carminic acid, its spectrum differs significantly. As the concentration is relatively high, there was no problem in extracting an appropriate, well-developed spectrum. It is clear therefore that this is another red dyestuff.

In both black samples the detection of an ellagic acid equivalent indicates the use of tannins. Both samples contain iron, whereas no copper was detected. Although theoretically the iron could originate from the salt-mine, it is likely that an iron bearing mordant was used together with tannins to get an iron-gall black. Due to the fact that iron-gall black dyeing was combined with vat dyeing and dyeing with yellow or red dyestuffs, very dark and intensive blacks were obtained.

Furthermore in the wool of the textile 89893 Ryder[46] identified 99 % pigmented fibres, while the fibres of the other black textile were not analysed. It is evident that in prehistoric times brown and black wool were dyed to produce deep black colours. In a black fabric from Altrier (Luxemburg, Early Latène Period) indigotin has been detected on naturally coloured brown wool[47]. To produce the black colour of the Hallstatt textile 89893, black wool was presumably dyed with an iron-gall black, with woad and additionally with unknown red dyestuffs.

Reddish brown and brown samples

The most common method to dye brown is by using tannins. In addition, brown or reddish brown colours can be obtained by a mixture of red and blue dyestuffs or when yellow dyestuffs are applied on an iron mordant.

Three reddish brown (73347, 75916, 89835), three brown samples (75977/1, 75977/2, 78551), and a yellowish brown textile (81160) were analysed; the results are given in Tab. 4. It is interesting that in none of these samples were tannins identified.

Most of the colours were achieved by dyeing white wool using flavonoid dyes combined with red dyes and blue indigotin, probably derived from woad. The concentration of indigotin was low. In the reddish brown sample 89835, shown in Plate 12/5, and in the yellowish brown sample 81160, a dyestuff was found which probably indicates the use of orchil. The other red dye- stuffs present in these samples remain unidentified.

In all samples flavonoids were detected. Luteolin and apigenin, which were detected in the samples 89835 and 75977#1 (Plate 6/2) could indicate the use of weld. In four other samples, no luteolin was found but apigenin, although the identification was complicated due to the low

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[43] Hundt 1959: 84-85.

[44] Hundt 1959: 97-100.

[45] Barber 1992: 227-228.

[46] Ryder 2001: 233.

[47] Kurzynski 1996: 41.

Sample, Colour	Element	Dyestuffs	Dyes
88892 Black	Fe and traces of Al and Si	Indigotin	Woad
		Probably luteolin, tr 21.42 abs 343 nm Probably apigenin, Tr 22.91 abs 343 nm Unknown flavonoid, tr 16.46 abs 348 nm Unknown flavonoid, tr 19.43 abs 343 nm Unknown flavonoid, tr 22.21 abs 348 nm	Likely weld
		Ellagic acid equivalent, tr 20.12 abs 361 nm	Tannins
89893 Black	Fe and traces of Al and Si	Indigotin, indirubin equivalent	Woad
		Unknown red compound, tr 16.41 abs 511 nm, relative high response, Some fluorescence compounds, red.	Unknown red dye
		Ellagic acid equivalent, tr 20.67 abs 361 nm	Tannins

Tab. 3: Hallstatt textiles, dyestuff-analysis: results of SEM-EDS analysis and HPLC analysis of the black textiles (© ICN / University of Applied Arts Vienna, Dept. Archaeometry).

concentration. This could mean that luteolin was under the detection limit of the system, due to selective degradation, or that another dye plant was used. Some plants only contain apigenin, such as Stinking Chamomile (*Anthemis chia* L.), Sawwort (*Serratula tinctoria* L.) and the leaves of the *Galium* species[48]. Since there were no other specific colorants present, the identification of this dye plant was impossible. Furthermore, degradation can alter the concentration of the dyestuffs in a sample. Research to determine the light fastness of textiles dyed with heather (*Calluna vulgaris* L.*)* indicates that of the dyestuffs apigenin, kaempferol and quercetin, apigenin is the most stable[49]. However, one cannot conclude that this is also the case under the conditions in the mine.

As mentioned above, it was impossible to determine whether the elements found could have been applied as a mordant or were contaminants from the mine. However, the final colour observed can be the effect of the presence of iron and copper. Copper was found in all samples and iron in five out of seven samples. As a result, flovonoid yellows could be altered to brownish or olive-brown shades. Generally anthraquinone reds could have been changed into a reddish brown or violet. The situation is even more complicated, since mixtures of red, yellow and blue dyes were applied. For that reason, the original colour could not be determined.

Unidentified red dyestuffs in Iron Age Textiles

In the different Hallstatt textiles several red dyestuffs were found, sometimes in high concentration. The spectra of the red colorants are given in Fi. 5a and 5b. Kermesic acid was clearly identified by its spectrum and retention time. The spectra of carminic acid and orchil respectively were not well-developed due to the low response. They could be identified, however, by their retention time. Two red dyestuffs were found, the spectra of which did not match with any red colorant found in reference materials. Particularly the component producing spectrum 4 was present in a relative high concentration and a well-developed spectrum was obtained. As reference materials for most of the important red dyestuffs were analysed, redwood, madder, *Galium* species, lichen dyes and fungus dyes of *Dermocybe* species can be excluded. The origin of these two dyestuffs remains unknown.

Interestingly, other research indicates the use of unknown red dyes as well. By using UV/Visible spectrophotometry and thin-layer chromatography Walton Rogers found an unidentified red dyestuff in one of the Hallstatt textiles (73347)[50]. The result indicates a mordant dye with an absorption spectrum close to that of madder and galium, but not identical. In addition, an unidentified red dyestuff was found in a textile from Lønne Hede, different from the dyestuff in the Hallstatt textile sample. According to her research, the following dyes can be eliminated: madder, *Galium* species, redwoods, insect dyes and fungus reds.

Conclusions

Correlation between the different samples

In the seventeen samples, twenty-five different colorants were detected, but not all of them could be identified. Based on the results of dyestuff analysis, the dyes which could have been used for dyeing the Hallstatt textiles are listed in Tab. 5. Even if identification was not possible, it often can be indicated from which dye source the compo-

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[48] Schweppe 1992: 349, 351. – Böhmer 2002: 196. – Hegnauer 1963-1973.

[49] Ferreira 2001: 149-150.

[50] Bender Jørgensen and Walton 1986: 186. – Walton 1988: 155.

Sample, Colour	Element	Dyestuffs	Dyes
73347 Reddish brown	Traces of Cu, Fe, Al and Si	Indigotin (low response) Probably apigenin, tr 22.84 abs 343 nm Unknown flavonoid, tr 19.91 abs 334 nm Unknown flavonoid, tr 21.17 abs 339 nm	Woad Unknown yellow dye
75916 Reddish brown	Traces of Cu	Apigenin Unknown flavonoid, tr 19.40 abs 348 nm	Unknown yellow dye
89835 Reddish brown	Cu and traces of Fe	Luteolin, apigenin Indigotin, indigotin equivalent Possibly orcein, tr 21.45 abs 555 nm	Likely weld Woad Possibly orchil
75977 #1 Light brown	Cu and traces of Fe	Luteolin, apigenin Indigotin and indirubin (low response)	Likely weld Woad
75977 #2 Dark brown	Cu and traces of Fe	Probably Apigenin, tr 22.47 abs 343 nm	Unknown yellow dye
78551 Brown	Cu and traces of Fe	Indigotin (low response) Maclurin equivalent Probably apigenin, tr 22.97 abs 343 nm Unknown red compound, tr 17.94 abs 462 nm	Woad Unknown yellow dye Unknown red dye
81160 Yellowish brown	Cu	Indigotin (low response) Quercetin Unknown red compound, tr 18.09 abs 467 nm Possibly orcein, tr 21.36 abs 555 nm	Woad Unknown yellow dye Unknown red dye Possibly orchil

Tab. 4: Hallstatt textiles, dyestuff-analysis: results of SEM-EDS analysis and HPLC analysis of the reddish brown, brown and yellowish brown textiles (© ICN / University of Applied Arts Vienna, Dept. Archaeometry).

nents were derived. For example six compounds, indigotin, indigotin equivalent, indirubin, indirubin equivalent, isatin and an unknown yellow compound are all correlated with an indigotin dye, which was most presumably woad. It is remarkable that in most of the samples woad was found.

Several yellow dyestuffs, all belonging to the flavonoid dye class, were found. In almost all samples flavonoids were detected. From the results of dyestuff analyses one can draw the conclusion that different dye plants must have been used for dyeing yellow. The luteolin and apigenin-containing plant is most probably weld, although the ratio between luteolin and apigenin is different from the ratio known from weld-dyeings of textiles of much later periods. In four of the brown and reddish brown samples apigenin was present where luteolin was absent. This could indicate another dye plant, although weld could not be excluded since tne luteolin could be degraded completely. Weld and the apigenin-containing dye were not found in the blue samples and in just one of the black samples.

The origin of the quercetin identified in the blue textiles and in one yellowish brown textile, sometimes together with ellagic acid, is unknown. It is remarkable that quercetin was never found with luteolin or apigenin. The presence of quercetin, which is one of the most widespread flavonoids in plants, indicates another dye plant source. Just possibly, it originates from woad in which it occurs as a minor component. The origin of many unidentified yellow dyestuffs found in the samples is also unknown, but these could be minor components since they all were found in combination with luteolin, apigenin or quercetin.

Five different red dyestuffs were found. An insect dye was identified in a greenish blue and in the blue samples, but not in the other samples. The presence of a red colorant, probably indicating the use of orchil, was surprising. Orchil is known for its instability, yet it was found in one blue, one reddish brown and in one yellowish brown sample. In three samples different red colorants were detected that could not be identified.

Tannins were found in the black, in a greenish blue and in the blue samples, but not in other samples. The presence of tannins, in combination with iron, indicates the use of an iron-gall dye in the black samples. To improve the colour, woad was applied as well, together with a red dye in one

Tab. 5: Hallstatt textiles, dyestuff-analysis: dyes identified in textile fragments from the prehistoric salt-mines of Hallstatt (© ICN / University of Applied Arts Vienna, Dept. Archaeometry).

Sample	Colour	Woad	Insect dye	Orseille ?	Unknown red dyestuffs	Weld ?	Apigenin dye	Quercetin dye	Unknown yellow dyestuffs	Tannins
77776c	Greenish blue	+						+		+
78526	Blue	+	?					+		+
79442a	Greenish blue	+	+					+	+	
89845	Blue	+	+	+				+	+	+
88892	Black	+				+			+	+
89893	Black	+			+					+
73347	Reddish brown	+					+		+	
75916	Reddish brown						+		+	
89835	Reddish brown	+		+		+				
75977#1	Ligh brown	+				+				
75977#2	Dark brown						+			
78551	Brown	+			+		+		+	
81160	Yellowish brown	+		+	+			+		
77334a	Yellow					+				
89725	Green	+				+				
75815	Olive green					+				
90129	Olive green	+								

sample and a yellow dye in the other. This clearly indicates that different dyes were used to produce dark shades. From this research it appears that the dyeing of textiles was much more common at that time than one would have supposed. No samples were found which were completely undyed. Dyestuffs were even identified on three textiles which were made of wool consisting of 98-100 % pigmented fibres. Vat dyeing with woad seems to be common. It was used together with a yellow mordant dye for green. However, the use of mordants could not be proved due to contamination, with the exception of the iron-gall black; mordants must have been used to obtain fast colours. Elements from mordants and from the mine could have affected the final colour.

Comparison with Iron Age textiles found in other European regions

The results of this project were compared to those from analytical research done on textile fragments from the Iron Age in Europe. An overview is given in Tab. 6. The number of investigations is still limited, so it is difficult to draw accurate conclusions. However, interesting trends can be observed.

The blue dyestuff indigotin, indicating the use of woad or indigo, was found in all regions. Although it is not possible to distinguish between indigo and woad, since the main component of both dyes is indigotin, woad is the most likely dye used in Europe at that time. Indigo originates from subtropical and tropical *Indigofera* species, so unless trade over long distances is a possibility, its presence in Europe at that date is unlikely.

Red dyes were found in Hallstatt, Hochdorf, Norway and Denmark. It seems that red dyes and the knowledge about their use were not widespread in the Iron Age. Madder and possibly *Galium* species were only found in Iron Age textiles from Scandinavia. While *Galium* species are native to Europe it is highly unlikely that madder was grown in northern Europe in the Iron Age and unless the dye itself were traded, the textile is most probably an import[51].

Insect dyes identified in textiles from Hallstatt, Hochdorf and Norway were probably kermes and Polish cochineal but identification is not always obvious. If kermesic acid only is detected, kermes was probably used for dyeing. The identification of kermesic and carminic acid points to Polish or Armenian cochineal. In the Hallstatt textiles pre-

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[51] Bender Jørgensen and Walton 1986: 185

Region and period	Woad or indigo	Madder	*Galium* sp. ?	Insect dye	Kermes ?	Polish cochineal ?	Orchil ?	Unknown red dyetsuffs	Weld ?	Apigenin dye	Quercetin dye	Unknown yellow dyestuffs	Tannins
Hallstatt, Austria, Hallstatt Period1)	+							+					
Hallstatt, Austria, Hallstatt Period2)	+			+		+	+	+	+	+	+	+	+
Hochdorf, Germany, Late Hallstatt Period3)	+			+	+			+					+
Hohmichele, Germany, Hallstatt Period3)	+												
Altrier, Luxemburg, Early Latène Period4)	+												
Grabenstetten, Germany, Hallstatt Period4)	+												
Norway, Iron Age5)	+	+		+		+							
Denmark, Iron Age5)	+		+									+	
Lønne Hede, Denmark, Iron Age6)	+							+					

Tab. 6: Dyes identified in Iron Age textiles from Europe. References: 1) Walton Rogers in Ryder 2001. – 2) Hofmann, Van Bommel & Joosten, see Tab. 5. – 3) Walton Rogers in Banck-Burgess 1999. – 4) Banck-Burgess 1999. – 5) Walton 1988. – 6) Bender Jørgensen and Walton 1986. (© ICN / University of Applied Arts Vienna, Dept. Archaeometry).

cise identification was not possible, because the ratio between these dyestuffs does not correspond to the ratios found in reference materials of any insect dye. It could be that a mixture of Polish or Armenian cochineal with kermes was applied. Alternatively, the ratio could be altered due to different degradation behaviour of kermesic acid and carminic acid. While in one Norwegian Iron Age textile of good quality Walton identified Polish cochineal by using UV/Visible spectrophotometry, in another one the dye may be either kermes or Polish cochineal[52]. The identification of an insect dye in all these regions always indicates trading of the dye or the textile.

Interestingly, some unknown red dyestuffs were found in Hallstatt, Hochdorf and Lønne Hede. Since different analytical techniques were used, it is not possible to determine if the same unknown red dyestuffs were found in these regions. In all investigations presented in Tab. 6, the results were compared to those from the analysis of reference materials: redwood, madder, *Galium* species, insect dyes, lichen dyes and fungus dyes of *Dermocybe* species could be excluded. Further research has to be carried out to determine if these unknown dyestuffs are degradation products. Alternatively, the unknown dyestuffs could indicate an unknown dye, knowledge of which was lost during the centuries.

From Tab. 6 it can be deduced that lichen dye and flavonoids were only detected in the present research. This could be due to the HPLC-PDA technique applied, which is generally more sensitive than TLC or spectroscopic identification [53].

One can conclude that in the Hallstatt Period and in the Iron Age complex dyeing processes were used. Textiles were dyed using vat dyes, mordant dyes and tannins. Considerable skills were developed for dyeing dark shades and blacks on Iron Age textiles in Norway[54], at Altrier[55] and Hallstatt. It was known how to obtain different shades by over-dyeing and mixing dyes.

Appendix

SEM-EDS analysis

Scanning electron microscopy was performed with an energy-dispersive X-ray spectrometer system (SEM- EDS, JEOL 5910LV). All samples were first coated with a thin layer of carbon to increase their conductivity. In the sample chamber of the microscope the samples were scanned under high vacuum by a finely focussed electron beam with an accelerating voltage of 20kV. When an electron beam scans the specimen's surface, interactions between the electron beam and the atoms composing the sample produce various kinds of information. Secondary electrons carry information on the topography of the sample surface, back scattered electrons on the composition and X-rays on the elemental composition. Due to the finely focussed beam of up to 2 µm it is possible to perform in situ microanalysis on the sample surface. The analysis is qualitative since the sample surface was not polished flat. The detection limit of the EDS system in high vacuum would be around 1 mass %.

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[52] Walton 1988: 156

[53] Hofmann-de Keijzer and Van Bommel 2005.

[54] Walton 1988: 153-154.

[55] Kurzynski 1996: 41.

HPLC analysis

All samples were first extracted with 50 µl dimethylformamide (DMF) for 10 minutes at 140ŽC. The DMF extracts were separated from the textiles and injected into the HPLC. Next, the samples were hydrolysed by addition of 50 µl reagent (water/methanol/hydrochloric acid, 1/1/2) to each sample in a 250 µl small insert vial. The vial was heated for 10 minutes in a water bath at 100 °C to extract and dissolve the dyestuffs. After the hydrolysis, the samples were evaporated to dryness and dissolved in 25 µl dimethylformamide. Prior to HPLC analysis, the samples were centrifuged for 2 minutes at 2000 rpm to remove precipitated matter. A sample volume of 10 µl was injected into the HPLC system.

The HPLC analyses were performed with equipment from Waters Chromatography BV (Etten-Leur, The Netherlands). The mobile phase was delivered at a flow rate of 0.2 ml/min by a 616 LC pump, controlled by a 600S controller. An in-line degasser degassed all effluents used. Samples were injected by a 717 autosampler. Detection was performed with a 996 Photo Diode Array (PDA) detector equipped with a 10 µl detector cell, scanning from 200 to 700 nm at a scanning rate of 1 scan/sec. The equipment was controlled by a computer with Millennium 32 software, version 4.0, from Waters Chromatography BV; the same system was used for data acquisition. Separation was performed on a luna C18 column (100 x 2 mm id) protected by a security C18 guard column, both supplied by Phenomenex (Torrance, CA, USA). The mobile phase consists of a gradient of water (HPLC grade 1, purified by a simplicity system Millipore, Amsterdam, the Netherlands), methanol (gradient grade, Fluka, Zwijndrecht, the Netherlands) and 5% phosphoric acid in water (acs reagent, Sigma, Zwijndrecht, The Netherlands). The constitution of the solvents and the gradient profile is given in Tab. 7.

Gradient	% A	% B	% C
Start	74	16	10
15 min	0	90	10
20 min	0	90	10
23 min	0	100	0
27 min	0	100	0
30 min	74	16	10

Tab. 7: Hallstatt textiles, dyestuff-analysis: gradient profile of HPLC system (© ICN).

Farbstoff- und Elementanalyse an Textilien aus dem prähistorischen Salzbergwerk Hallstatt

Im bronzezeitlichen und hallstattzeitlichen Salzbergbau von Hallstatt wurden seit 1849 ungefähr 230 Textilfragmente gefunden, von denen fast alle aus Wolle bestehen. Dank der konservierenden Wirkung des Salzes und dem in der Mine herrschenden konstanten Klima blieben nicht nur die Fasern, sondern auch die Farben der Textilien erhalten.

Die Farbnuancen der rund 140 hallstattzeitlichen Textilien variieren von Gelb und Olivgrün bis Grün, Braun, Rötlichbraun, Grünlichblau, Blaue und Schwarz.

Im Jahre 2002 wurde in Zusammenarbeit zwischen der Prähistorischen Abteilung des Naturhistorischen Museums Wien, des Research Department des Netherlands Institute for Cultural Heritage in Amsterdam und der Abteilung Archäometrie der Universität für angewandte Kunst Wien das multidisziplinäre Forschungsprojekt Halltex 1 zur naturwissenschaftlichen Untersuchung der farbigen Textilien gestartet. Es wurden 17 Proben analysiert, die alle in den Textilfragmenten vorkommenden Farbnuancen abdeckten.

Lichtmikroskopie und Rasterelektronenmikroskopie mit energie-dispersiver Röntgenanalyse (REM-EDX) dienten zur Faseranalytik. In den verschiedenen Textilien wurden Wollfasern mit gut erhaltenen oder mit abgebauten Schuppen gefunden (Fig. 1a und 1b). Bei fast allen Proben waren die Fasern mit anorganischen Partikeln kontaminiert, bei einigen besonders stark (Fig. 2a). Fasern mit abgebauten Schuppen wiesen Risse und Brüche auf (Fig. 2b).

Mit REM-EDX wurden auf den Wollfasern sehr kleine Areale von 30 x 30 µm zwischen den Schmutzpartikeln gemessen, um nur die in den Fasern vorkommende Elemente zu analysieren. Für die Untersuchung der Färbungen waren vor allem jene Elemente wichtig, die aus Beizmitteln stammen könnten (Aluminium, Eisen, Kupfer) oder die während der Lagerung im Heidengebirge in die Fasern eingedrungen sein könnten und die Färbungen der Textilien nachträglich verändert haben könnten (Eisen, Kupfer). Als Eisenquelle kommen eisenhaltige Salzmineralien in Frage, als Kupferquelle abgebrochene Bronzepickelspitzen (Plate12/2-5). Eisenhaltige und kupferhaltige Verbindungen führen zum Abdunkeln von Beizenfärbungen (Plate 12/1).

Die Herkunft der Elemente – aus einem Beizmittel oder aus der Salzmine – kann nur indirekt bestimmt werden. Aluminium wurde in allen Proben nur gemeinsam mit Silizium analysiert, das sicher aus dem Bergwerk stammt. Daher ist anzunehmen, dass das gefundene Aluminium ebenfalls aus dem Bergwerk stammt. Die Verwendung eines aluminiumhaltigen Beizmittels konnte daher nicht nachgewiesen werden. Es ist nicht bekannt, ob Kupfer, das manchmal in größeren Mengen gefunden wurde, nur aus dem Heidengebirge stammt oder ob auch ein kupferhaltiges Beizmittel benutzt wurde. Da in beiden schwarzen

Textilfragmenten (Plate 13/2) Eisen zusammen mit Gerbstoffen nachgewiesen wurde, kann man mit großer Wahrscheinlichkeit annehmen, dass eisenhaltige Beizmittel zur Erzeugung eines Eisengallus-Schwarz benutzt worden sind.

Die Analyse der Farbstoffe erfolgte mit Hochleistungs-Flüssigkeitschromatographie mit Photo-Dioden-Array-Detektion (HPLC-PDA). Wie bei anderen fragilen archäologischen Textilien wiesen die Chromatogramme eine Störung der Basislinie auf, wodurch die Identifikation der Komponenten erschwert wurde (Fig. 3). Insgesamt wurden 25 Farbstoffe analysiert und daraus konnte auf die Verwendung von mehr als sieben Färbedrogen geschlossen werden (Tab. 1-4, Tab. 5). Die Identifikation der Färbedrogen war schwierig, da es noch keine Erfahrung mit HPLC-PDA-Fingerprints von in der Hallstattzeit verwendeten Färbedrogen gab und die Abbaumechanismen von Farbstoffen in Salzminen nicht bekannt sind. Da sowohl Textilien als auch Färbedrogen über weite Strecken gehandelt und auch lokale wachsende Färbepflanzen benutzt worden sein können, kommen ein Vielzahl an Färbedrogen in Betracht.

Indigotin wurde in dreizehn Proben aus allen Farbnuancen nachgewiesen, in größerer Konzentration analysierte man Indigotin in grünlichblauen, blauen (Plate 13/1) und schwarzen Textilien (Plate 13/2) und im grünen Textil. Der Nachweis von Indigotin weist auf die Färbungen mit einer Indigopflanze hin. Bisher können mit verschiedenen Indigopflanzen durchgeführte Färbungen nicht an Hand von Nebenkomponenten chemisch unterschieden werden. Mit großer Wahrscheinlichkeit wurde der Färber-Waid (*Isatis tinctoria* L.) benutzt, da er zu dieser Zeit bereits in Europa kultiviert wurde und der Import von Indigo aus Asien oder Afrika sehr unwahrscheinlich ist. Fig. 4 zeigt das Spektrum einer unbekannten gelben Komponente, die in Indigotin-Färbungen der Hallstatt-Textilien und in Indigotin-Färbungen von spätantiken Textilien aus Ägypten analysiert wurde.

In fünfzehn Proben wurden drei verschiedene Flavonoide nachgewiesen, einzeln oder in Kombination. In je einem gelben (Plate 13/3), grünen (Plate 8/3), olivgrünen (Plate 13/4), braunen (Plate 6/2), rötlichbraunen (Plate 12/5) und schwarzen Textil (Plate 13/2) wurden Luteolin und Apigenin analysiert, woraus man schließen kann, dass höchstwahrscheinlich der Färber-Wau (*Reseda luteola* L.) benutzt wurde. Eine eindeutige Identifikation war nicht möglich, da Luteolin und Apigenin in gleicher Konzentration gefunden wurden, während in Wau-Färbungen normalerweise viel mehr Luteolin als Apigenin vorkommt. Entweder wurde Luteolin in der Mine rascher abgebaut als Apigenin oder im Wau der Hallstattzeit kamen die Farbstoffe in anderen Konzentrationen vor oder eine andere Pflanze wurde benutzt.

In braunen und rötlichbraunen Texilien wurde nur Apigenin und kein Luteolin nachgewiesen. Zum Färben dieser Textilien wurde entweder eine unbekannte Pflanze verwendet, oder es handelt sich um Wau-Färbungen, bei denen das Luteolin vollständig abgebaut worden ist. Quercetin wurde in allen blauen Textilien (Plates 7/4 und 13/1), manchmal zusammen mit Gerbstoffen, und in einem gelbbraunen Textil gefunden. Die Herkunft dieses häufig in Pflanzen vorkommenden Flavonoids ist unbekannt. Es gibt zahlreiche quercetinhaltige Farbstoff- und Gerbstoffpflanzen. Es könnte sogar aus dem Färber-Waid stammen, in dem es als Nebenkomponente vorkommt. Allerdings müssten dann in der Hallstattzeit für die Waid-Färbung Techniken angewendet worden sein, bei denen auch Beizenfarbstoffe auf die Fasern aufziehen konnten, was bisher bei Küpenfärbungen nicht beobachtet wurde.

Eine unbekannte Gerbstoffdroge wurde zum Färben von blauen und schwarzen Nuancen benutzt. Auffällig war, dass in keinem einzigen braunen Textil ein Gerbstoff gefunden wurde, obwohl man mit Gerbstoffen auf einfache Art (Direktfärbung) Brauntöne erzielt. Die Brauntöne der untersuchten Proben entstanden entweder durch mehrere Färbeprozesse unter Anwendung von gelben und roten Farbstoffen und Waid und/oder durch den Einfluß von eisen- und kupferhaltigen Verbindungen auf gelbe Flavonoidfärbungen. Falls diese Verbindungen erst in der Mine in die Textilien eingedrungen sind, haben sie die Originalfarbe verändert.

Es wurden fünf verschiedene rote Farbstoffe nachgewiesen (Fig. 5). In blauen Textilien (Plates 13/1 und 7/4) wurden Kermessäure und vermutlich Karminsäure identifiziert, woraus man auf die Verwendung von Färbe-Insekten schließen kann. Mit HPLC-PDA kann man durch quantitativen Vergleich von Haupt- und Nebenkomponenten die mit Kermes, Polnischer Cochenille oder Armenischer Cochenille durchgeführte Färbungen eindeutig voneinander unterscheiden. Doch das in den untersuchten Textilien gefundene Verhältnis zwischen Kermessäure und Karminsäure entspricht keinem der bekannten Färbe-Insekten. Es könnte sein, dass dies auf unbekannte Abbaumechanismen in der Mine zurückzuführen ist oder dass eine Mischung von Färbe-Insekten benutzt wurde.

In zwei braunen (Plate 12/5) und in einem blauen Textil (Plate 13/1) wurde ein roter Farbstoff gefunden, der aus Orseille, einer aus Flechten hergestellten Färbedroge, stammen könnte. Zwei rote Farbstoffe sind unbekannter Herkunft.

Es war bemerkenswert, dass in allen Proben, auch in jenen, die wie braune oder schwarze naturfarbene Wolle aussehen, zumindest ein Farbstoff gefunden wurde. Daraus folgt, dass das Färben bei der Textilherstellung in der Hallstattzeit weit mehr angewendet wurde als bisher angenommen. Küpenfärberei scheint allgemein verbreitet gewesen zu sein (Tab. 5 und 6).

Sowohl direkt färbende Gerbstoffe als auch gelbe und rote Beizenfarbstoffe wurden verwendet. Färbungen mit Färbe-Insekten, Krapp, *Galium*-Arten, Gerbstoffen und unbekannten roten und gelben Farbstoffen wurden bereits von Walton Rogers in eisenzeitlichen Textilien mit UV/Visible Absorption Spektrophotometrie und Dünnschicht-Chromatographie gefunden (Tab. 6). Bei der Untersuchung der Hallstatt-Textilien wurden erstmals in eisenzeitlichen Textilien gelbe Flavonoide und ein Flechtenfarbstoff analysiert, was vor allem auf die angewandte Analysemethode (HPLC-PDA) zurückzuführen sein dürfte, mit der Farbstoffe in geringsten Konzentrationen nachgewiesen werden können.

Obwohl nur bei den schwarzen Eisengallus-Färbungen auf die Verwendung eines Beizmittels geschlossen werden konnte, müssen auch bei den anderen Beizenfarbstoffen Beizmittel benutzt worden sein, um dauerhafte Färbungen zu erzielen.

Olivgrüne Färbungen scheinen auf verschiedene Ursachen zurückzuführen zu sein, bei denen Kupferverbindungen eine Rolle spielen. In beiden olivgrünen Textilien wurde nur Kupfer und kein Eisen nachgewiesen. Es ist unbekannt, wann die Kupferionen in die Textilien gekommen sind. Bei einem olivgrünen Textil (Plate 13/4) wurden die gelben Beizenfarbstoffe Luteolin und Apigenin nachgewiesen. Eine gelbe Flavonoid-Färbung wurde durch Kupferionen ins Olivgrüne verschoben, sei es schon während des Färbevorgangs durch kupferhaltige Beizmittel oder erst während der Lagerung im Heidengebirge. Beim zweiten olivgrünen Textil, bei dem nur der Küpenfarbstoff Indigotin identifiziert wurde, könnten flavonoide Verbindungen unter der Nachweisgrenze liegen. Falls aber nur eine Indigotin-Färbung vorliegt, war beim Färben kein Beizmittel nötig und die olivgrüne Färbung eines ursprünglich vermutlich blauen Textiles, dürfte nur auf Kupferverbindungen zurückzuführen zu sein, die in der prähistorischen Mine in das Textil eingedrungen sind.

Man kombinierte Färbedrogen und Färbetechniken, um bestimmte Farbnuancen zu erzielen. Grün (Plate 8/3) färbte man mit einer gelbfärbenden Droge, vermutlich mit dem Färber-Wau, und mit einer blaufärbenden Droge, dem Färber-Waid. Besonders aufwendige Färbeverfahren benutzte man für blaue und schwarze Farben. Für Blau wurde nicht einfach eine Waidfärbung durchgeführt, sondern man verwendete zusätzlich Gerbstoffe und gelbe und rote Farbstoffe, um bestimmte blaue Nuancen zu erzielen. Aus dem Nachweis von Färbe-Insekten in zwei blauen Textilien (Plate 13/1) kann man auf den Import der Färbe-Insekten oder der Textilien schließen, weil diese Insekten in der Umgebung von Hallstatt nicht vorkommen. Da die Färbedroge nicht identifiziert werden konnte, weiß man nicht, woher das Färbe-Insekt stammt. Kermes kommt im Mittelmeerraum vor, die Polnische Cochenille in Nordosteuropa und die Armenische Cochenille um den Berg Ararat.

Dunkle Schwarztöne (Plate 13/2) wurden sowohl auf weißer als auch auf brauner Wolle mit Gerbstoffen und eisenhaltigen Materialien (Eisengallus-Schwarz) erzeugt und zusätzlich noch mit Waid und gelben oder roten Farbstoffen gefärbt.

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Curricula vitae

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Untersuchungen zum Erhaltungszustand der „Hallstatt-Textilien“

Michaela Morelli

Abstract

Im Rahmen dieser Arbeit wurden einerseits Informationen zur bisherigen Handhabung und Behandlung der Fragmente aus dem Salzbergwerk von Hallstatt gesammelt, andererseits die Stücke sowohl mit freiem Auge als auch unter dem Mikroskop auf Schäden untersucht. Da die Fundstücke seit über 150 Jahren laufend ausgegraben werden war die Ermittlung der Schadensursache über Vergleiche zum Großteil möglich.

In the course of this work information was gathered concerning the treatement of the textile specimens from the salt-mines at Hallstatt during the last 150 years. The other main point was to check all specimens for damages macroskopically as well as under microscope. Because the textiles were excavated during the last 150 years, in most cases we were able to find the specific reasons for the damages.

Einführung

Im Jahre 2003 wurde ich mit verschiedenen Fragestellungen zum Thema Reinigung, Konservierung, Aufbewahrung, Transport etc. der „Hallstatt-Textilien“ konfrontiert. Es war schnell klar, dass vor jeder konservatorischen Auseinandersetzung mit den Stücken deren aktueller Erhaltungszustand erfasst werden muss.
Außerdem sollen alle möglichen Ursachen für den mehr oder weniger schlechten Zustand und den zum Teil starken Materialabbau zusammen getragen werden.

Zuallererst muss bei der Untersuchung zum Erhaltungszustand bedacht werden, dass wahrscheinlich alle Textilien aus den prähistorischen Bergwerken in sekundärer bzw. tertiärer Funktion Verwendung fanden, bevor sie mit anderem unbrauchbar gewordenem Material und Salz am Boden im Berg liegen blieben.
Dies bedeutet, dass die Stücke bereits in der Bronzezeit/Eisenzeit nicht mehr sehr gut erhalten waren. Es handelt sich um Fragmente, welche oft zerrissene/gerissene Ränder aufweisen. Nur selten sind Webkanten und Säume, sowie Anschusskanten oder Borten vorhanden.

Was bisher mit den Fragmenten geschah

Zur bisherigen Handhabung und Behandlungsweise der Textilfragmente aus dem Salzbergwerk von Hallstatt konnten folgende Informationen und Beobachtungen gesammelt werden:

* Die Textilien werden seit über 150 Jahren aus dem Bergwerk geborgen und wurden nach der Bergung vor Ort in Quellwasser gewaschen und gespült (siehe K. Grömer, The Textiles from the prehistoric Salt-mines at Hallstatt, in diesem Band, Fig. 1).
* Einige Stücke wurden anschließend in der Sammlung nass nachbehandelt. Laut Dr. Barth wurden noch anhaftende Verunreinigungen in einem Wasserbad (destilliertes Wasser) gelöst. Die Fragmente wurden in diesem Fall mit dem Wasserstrahl aus einem feinen Glasröhrchen, welches an einem Wasserschlauch angesteckt war, unter Wasser gereinigt.
* Sieben Textilfragmente befinden sich in der Dauerausstellung (Fig. 1). Sie sind mit Stecknadeln auf eine textilbespannte Weichfaserplatte vertikal genadelt und den fortwährenden Klimaschwankungen sowie schädigenden UV-Strahlen (photochemischer Abbauprozess) der Beleuchtung ausgesetzt.
  Die Stecknadeln verursachen mechanische Schäden (Löcher durch das Eigengewicht der Fragmente, Einstiche in den Faserverbund); die Dämpfe aus der Weichfaserplatte (Formaldehyd, andere Lösemittel etc.) bewirken eine chemische Schädigung.
* Bis Anfang der 90er Jahre des 20. Jahrhunderts wurden die Textilien in Eichenschränken aufbewahrt, welche zwar kurzfristige Klimaschwankungen auszugleichen vermochten, deren Säuren aus dem Eichenholz jedoch sicherlich auch schädigenden Einfluss auf die Erhaltung hatten.
* Bis 1998 waren alle Stücke den Klimaschwankungen in den Schau- bzw. Arbeitsräumen ausgesetzt, erst danach kamen sie in den klimatisierten Tiefspeicher in einen Planschrank.
* Neun der ältesten Textilfragmente wirken flachgepresst und werfen sich zum Teil schüsselförmig auf (Plate 14/a). Es handelt sich um die ersten Textilfragmente aus dem Bergwerk, welche Mitte des 19. Jahrhunderts im Kernverwässerungswerk gefunden wurden und kurz danach im Kunsthistorischen Museum Wien ausgestellt

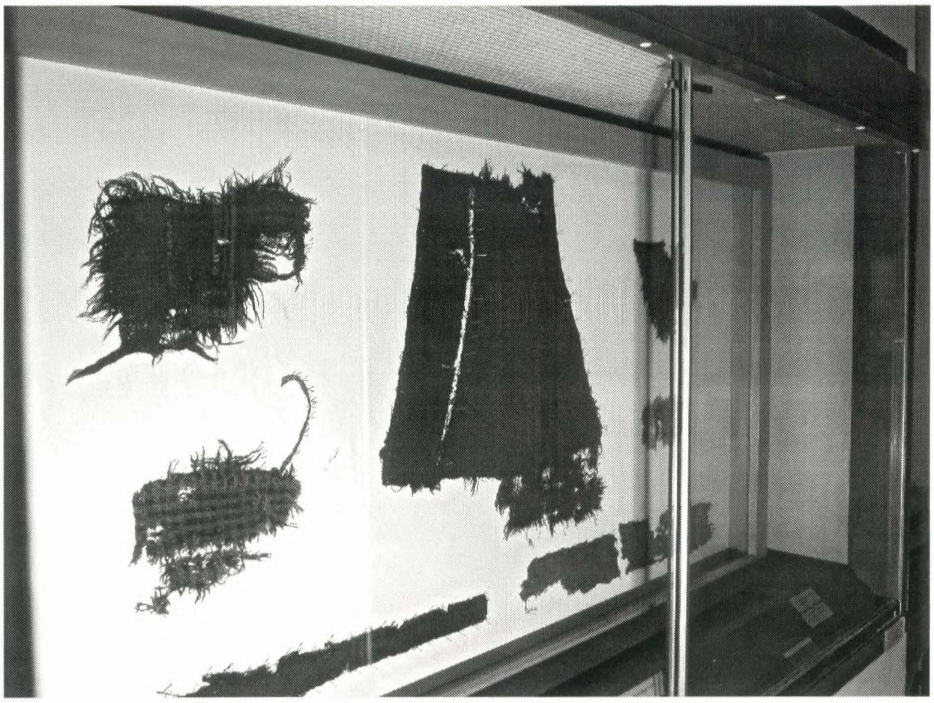

Fig. 1: Vitrine im Naturhistorischen Museum Wien mit den ausgestellten Hallstatt-Textilien. *Presentation of the textiles at the Museum of Natural History Vienna* (© Naturhistorisches Museum Wien, Prähist. Abteilung).

wurden. Im Anschluss daran wurden Nachbildungen in Form kolorierter Kartonabdrücke (Plate 14/d) auf einer damals allgemein üblichen Kopierpresse angefertigt [1].

* Einige Stücke wurden ausgelegt und wirken heute zum Teil gekämmt.
* Andere Fragmente weisen heute einen klebrigen Griff auf und sind zum Teil sehr steif (Plate 14/c). Sie wurden höchstwahrscheinlich mit einem Festigungsmittel behandelt.
* Sieben Fragmente wurden verglast (Fig. 2).

Erste Durchsicht der Fragmente

Alle mir im Zeitraum Januar 2004 bis Mai 2004 zugänglichen Stücke wurden in einer ersten Durchsicht mit freiem Auge und Lupe auf ihren Erhaltungszustand untersucht.

Eine schnelle Durchsicht nach einfachen, vorher festgelegten Kriterien wurde bewusst gewählt, um insgesamt 165 Textilfragmente in einem „Guss“ zu beurteilen und einen Gesamtüberblick des Erhaltungszustandes der Stücke zu schaffen. Es wurde besonders auf abgefallene Partikel, sowie auf die Elastizität der Fasern/Fäden geachtet und Augenfälligkeiten festgehalten.

Der Erhaltungszustand jener Stücke, welche sich in der Dauerausstellung befinden, ist eindeutig am schlechtesten. Die Fasern sind von allen Fragmenten äußerst brüchig und unflexibel. Die ausgestellten Stücke wurden alle vor 1901 ausgegraben, lediglich eines stammt aus dem Jahre 1966. Die vergleichbaren Fragmente von 1966 aus dem gleichen Fundkomplex, welche im Depot gelagert wurden, weisen alle einen guten bis mäßig guten Erhaltungszustand auf. Grund für den starken Materialabbau der ausgestellten Stücke ist mit großer Wahrscheinlichkeit das instabile Klima – mit großen Schwankungen von Temperatur und Luftfeuchte während des gesamten Jahres – sowie die permanente Belastung durch schädigende UV-Strahlen der Beleuchtung.

Insgesamt befinden sich die „älteren“ Stücke mit niedriger Inventarnummer in wesentlich schlechterem Zustand, als die „jüngeren“ mit höherer Inventarnummer. Dies wiederum legt den Rückschluss nahe, dass die schlechten klimatischen Bedingungen im Hause während der letzten 150 Jahre maßgeblich an der raschen Alterung der Fragmente beteiligt waren.

Ein Großteil der jüngeren Textilfragmente weist leichte bis starke lehmige Verschmutzung auf (Plate 14/b), welche auf die Fasern versprödend wirkt. Es ist auffällig, dass die von 1846 bis 1967 geborgenen Textilfragmente keinerlei oder nur wenig Verschmutzungen aufweisen. Danach, vor allem ab den 80er Jahren des 20. Jahrhunderts ist eine beträchtliche Anzahl an Fragmenten davon betroffen. Ab 1967 sind 43 % der untersuchten Fragmente mit lehmiger Verschmutzung verbacken bzw. behaftet, 57 % sind ohne Verschmutzung.

Weiters ist bemerkenswert, dass der Fundort keinen wesentlichen Einfluss auf diesen Zustand der Textilfragmente hat.

Je nach Fundort fällt die Zusammensetzung des Heidengebirges sehr unterschiedlich aus. Beispielsweise gilt das

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[1] Vermutung von F. E. Barth, Naturhistorisches Museum Wien.

Heidengebirge im Kernverwässerungswerk als stark salzhaltig, im Christian-Tuschwerk als stark lehmhaltig[2].

Das Auswaschen von Salz ist wesentlich einfacher, als das von Lehm. Das bedeutet, dass Fragmente aus dem Kernverwässerungswerk weniger Verschmutzungen aufweisen sollten, als solche aus dem Tuschwerk. Dies lässt sich allerdings aus den Untersuchungen zum Zustand der Stücke nicht ablesen: beispielsweise wurden insgesamt 77 Fragmente aus dem Kernverwässerungswerk untersucht, davon 15 Stück von vor 1967, die keinerlei lehmige Verschmutzungen aufweisen. Unter den 62 Exemplaren, welche nach 1967 in der Sammlung Eingang fanden, sind 37,5 % (24 Stück) lehmig verschmutzt.

Die schlüssige Erklärung für diese Erscheinung liegt wohl eher in der Vorgangsweise beim Auswaschen und Spülen der Fundstücke, bzw. bei deren Nachbearbeitung oder Nicht-Nachbearbeitung im Museum.

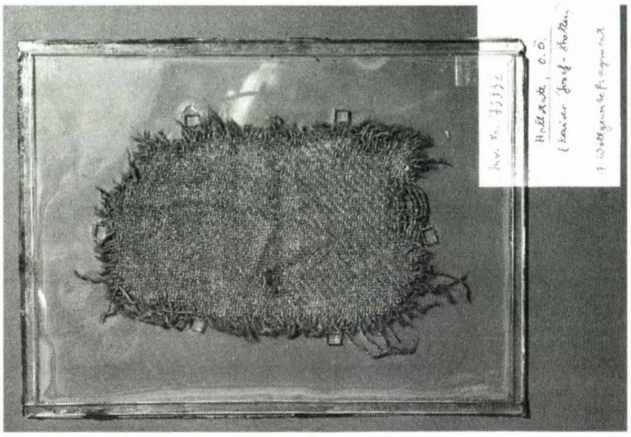

Fig. 2: Hallstatt-Textilien: Verglastes Fragment mit Abstandhaltern. *Glass mount with fragment and mount elements* (© Naturhistorisches Museum Wien, Prähist. Abteilung).

Fasermikroskopische Untersuchung

In einem zweiten Arbeitsschritt wurden aus 16 Textilfragmenten Fasern entnommen und unter dem Durchlichtmikroskop auf Schäden untersucht.

Grundlage für folgende Untersuchung waren Fragmente aus ein und demselben Fundkomplex, dem Kernverwässerungswerk. Ein Teil dieser Fragmente wurde vor über 155 Jahren ausgegraben, der andere Teil ging 1990 in den Sammlungsbestand ein.

Ziel der Untersuchung war es einerseits zu sehen, ob man Schäden am Fasermaterial feststellen kann, andererseits sollte der Zustand der Fasern aus den verschiedenen Fragmenten untereinander verglichen werden, um weitere Schlüsse auf die Schadensursachen für den Materialabbau der Stücke ziehen zu können. Es wurden jeweils aus Kette und Schuss im Randbereich der Fragmente Faserproben entnommen und diese in Glyzerin/Wasser entm. eingebettet.

Es konnten unterschiedliche Schadensbilder an den Fasern festgestellt werden. Am häufigsten handelte es sich um Querbrüche in den Fasern, die zu mehreren Faserbruchstücken geführt haben (Plate 14/e). Außerdem konnten zahlreiche Querrisse, Längsrisse, Abspaltungen, Abschälungen, Knicke und andere Deformierungen (Plate 14/f) sowie splissige (Plate 14/g) oder schroff ausgebrochene Faserenden beobachtet werden. Hinzu kommen noch Auflagerungen von transparenten bis dunkel opaken Partikel (Plate 14/i), hier handelt es sich wohl zum Großteil um Fremdmaterial wie Salzminerale, welche unzureichend ausgewaschen wurden.

Beim Vergleich der Faserbilder innerhalb der untersuchten Fragmentgruppe konnte ein insgesamt schlechterer Zustand der Fasern jener Textilien, welche seit über 150 Jahren in der Sammlung sind, festgestellt werden. Dieses Ergebnis deckt sich weitgehend mit den allgemeinen Beobachtungen. Waren die Fasern/Fäden bei den Fragmenten fragil, verhärtet oder versprödet, zeigten sich unter dem Mikroskop die bereits oben genannten Schäden wie Querbrüche, Abspaltungen u.s.w. und kleinere Faserbruchstücke.

Wies ein Fragment elastische Fasern/Fäden auf und war insgesamt geschmeidig, waren auch dessen Fasern unter dem Mikroskop eher lang und hatten nur kleinere bzw. wenigere Schadstellen.

Ferner wurde jede Faser analysiert und ihre Faserstärke gemessen, um die Ergebnisse früherer Analysen zu überprüfen bzw. zu vervollständigen.

Im Wesentlichen kann nach diesen ersten Unteruchungen festgestellt werden, dass die wichtigsten konservatorischen Maßnahmen für die „Hallstatt-Textilien“ die Einhaltung konstanter klimatischer Bedingungen und der Einsatz unbedenklicher Materialien in der Ausstellung und im Depot sein müssen.

Da jede Handhabung der Textilien eine mechanische Schädigung der Fasern, besonders durch die versprödenden Verschmutzungen, verursacht sollte bei einem restauratorischen Konzept die Entfernung der lehmigen/salzigen Verkrustungen an erster Stelle stehen.

Examination of the state of preservation of the Hallstatt Textiles

The present condition of the Hallstatt textiles was examined in order to prepare a treatment proposal and find possible reasons for the badly deteriorated fibres.

What happened to the textiles before?

Textiles have been continuously excavated in the mines for 150 years. They were washed out from the Heidengebirge and ultimately entered the collection of the Natural

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[2] Freundliche Mitteilung Hans Reschreiter, Naturhistorisches Museum Wien – Vgl. Reschreiter, in diesem Band.

History Museum Vienna. The first textile finds (1849) from the Kernverwässerungswerk were already displayed in the second part of the 19th century. Of these card prints were made and later coloured. These fragments now appear flat and deformed (Plate 14/a,d).

Some pieces were laid out and partly appear as if they had been combed.

Some pieces were probably treated with consolidants. They are very stiff and/or tacky Plate 14/c).

The most "interesting" textiles scientifically were and are on display (Fig. 1). The pieces are pinned to a fabric covered mount and are exposed to fluctuating environmental conditions in the display areas.

Six of the first fragments and one from the 1960 campaign were mounted behind glass (Fig. 2). Fibres are partly adhered to a mount elements.

Preparatory work for the treatment proposal

In a first operation most part of the textiles were checked for condition with the naked eye. Particular attention was paid to detached particles and the flexibility of the pieces. Specific features such as accretion, soiling, discoloration, deformation and so on, were noted.

It was noted that the fragments, which had been in the collection for more than 150 years, were more brittle than the ones acquired within the last 10 to 40 years. However it was observed that the later pieces were more soiled with loam resulting in mechanical desiccation and brittleness of the fibres.

A greater part of the fragments, which were excavated since the eighties of the 20th century, show encrusted, loamy soiling resulting in brittleness of the fibres (Plate 14/b).

Until the beginning of the nineties the textiles had been stored in oak cases. These acted as a slight buffer against minor climate luctuations but they transpired acidic gases causing further damage to the textiles. Until 1998 all textiles from the collection were exposed to major climate fluctuations and were later transferred to the environmentally controlled basement storage.

In a second step fibres of 15 fragments from exactly the same location, the Kernverwässerungswerk, were examined. Eight of these fragments were excavated 155 years ago; seven of the sample pieces entered the collection in 1990. The fibre samples were embedded in glycerine/water and examined using a microscope focusing on breakage and damage, accretion, detached and loose particles (Plate 14/e-j).

Although more samples would have facilitated a more accurate result about the state of preservation of the fibres – that is always a problem when dealing with original objects – this examination and the first one with naked eye turned out to be conform.

The fragile condition of the pieces that had been in the collection for the last 150 years was in all probability caused mainly by poor environmental conditions, strong and recurrent fluctuations in temperature and relative humidity as well as damage by light during display.

For long term preservation of the Hallstatt textiles the main focus should be on environmental conditions and on the materials used for storage and display.

Acknowledgments

Herzlichen Dank an Dr. Anton Kern für die Zurverfügungstellung der Hallstatt-Textilien, an Hans Reschreiter für die freundliche Unterstützung, ebenso möchte ich mich bei Mag. Karina Grömer und Dr. Fritz Eckart Barth für die informellen Gespräche bedanken, herzlichen Dank an Regina Hofmann-de Keijzer.

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Curriculum vitae

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Neues Lagerungskonzept für die Textilien aus Hallstatt

Carine Gengler

Abstract

Für das neue Lagerungskonzept der textilen Funde aus Hallstatt wurden Tableaus angefertigt, auf denen die Textilien sowohl gelagert, als auch transportiert und ausgestellt werden können. Durch dieses Konzept und die Wahl der Materialien kann man gewisse Schadensfaktoren aus der Umwelt und durch Handhabungen vermeiden und so eine optimalere Lagerung ermöglichen.

For the new storage of the textile finds from Hallstatt, individual trays were created on which the textiles will be stored, transported and exhibited. Through this storage concept and the choice of materials used for the trays, some of the sources of damage can be avoide and so optimal storage and preservati conditions can be achieved.

Vorwort

Im Juni 2003 beschloss das Naturhistorische Museum Wien in Zusammenarbeit mit der Universität für Angewandte Kunst Wien – Ordinariat für Konservierung und Restaurierung, ein neues Konzept für eine verbesserte Lagerungssituation der textilen Funde aus dem Salzbergwerk Hallstatt zu entwickeln. Im Zuge einer Lehrveranstaltung wurde ein Konzept erstellt und dem Naturhistorischen Museum präsentiert. Die Realisierung der geplanten Maßnahmen begann im September 2003.
Seit 1998 werden die Textilien im Tiefspeicher des Naturhistorischen Museums in Wien aufbewahrt. Seitdem lagen sie jeweils einzeln in offenen Schachteln in einem Planschrank aus Metall. Durch Bewegung, beim Öffnen der Schubladen sowie beim Transport der Schachteln, verrutschten die Textilien auf dem glatten Boden der Schachteln, was einen Abrieb der Fasern zur Folge hatte.
Eine neue Aufbewahrungsmethode sollte daher folgende Anforderungen erfüllen:

* Konservatorisch adäquate Lagerung
* Einfache und risikofreie Handhabung
* Einfache Nutzung für Ausstellungen und Transport
* Leichte Einsicht in die Sammlung
* Anbringung von gut sicht- und lesbaren Inventarnummern

Das neue Konzept bestand darin, für jedes einzelne textile Fragment ein eigenes Tableau anzufertigen, auf dem sie sowohl gelagert, ausgestellt als auch transportiert werden können. Um den Kosten- und Zeitfaktor zu reduzieren, wurden zwei Arten von Tableaus entworfen: Variante A, ein flaches Tableau für Objekte, die voraussichtlich nie ausgestellt werden, Variante B, ein Tableau mit Negativbett, für Objekte welche zeitweise ausgestellt oder verliehen werden (siehe Fig. 1).

Materialien

Zur konservatorisch adäquaten Lagerung gehören neben einem stabilem Klima[1] und dem Schutz vor UV-Strahlung (Licht)[2], auch die Vermeidung von Schadstoffen. Innerhalb eines Museums sind die Materialien, die zur Lagerung der Objekte verwendet werden, die häufigste Quelle von Schadstoffen. So können flüchtige organische Säuren aus dem Verpackungsmaterial, den Schränken oder den Vitrinen abgesondert werden und die Alterung und Zersetzung von organischen Materialien beschleunigen.
Für den festen Kern der Tableaus wurde ein 3 mm starker Museumskarton ausgewählt. Dieser Karton ist im Gegensatz zu handelsüblichen Papieren und Kartons säurefrei und gibt daher keine Schadstoffe ab. Zusätzlich ist Karton hygroskopisch und atmungsaktiv, wodurch er als Puffer bei klimatischen Schwankungen dient und auch eine Luftzirkulation unterhalb des Objektes gewährleistet.
Eine Stärke von 3 mm war bei den kleineren Tableaus ausreichend, um eine gute Festigkeit zu bieten. Bei Formaten ab 40 cm Breite wurden zwei Lagen Karton verwendet, um auch hier Stabilität und eine flache Auflagefläche zu garantieren.
Die Tableaus wurden zunächst mit einer Schicht Molton[3] überzogen, der als weiche Zwischenlage und zusätzlicher Klimapuffer dient. Als äußerste und zugleich sichtbare Schicht wurde ein Baumwollgewebe verwendet, auf welchem die Textilien aufliegen. Dieses hat eine glattere

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[1] Für Textilen etwa eine Temperatur zwischen ca. 16°C - 20°C und eine relative Luftfeuchtigkeit zwischen 50 % und 55 %.

[2] Maximaler Wert von 50 LUX bei Ausstellungen.

[3] Aufgerauhter Baumwollstoff.

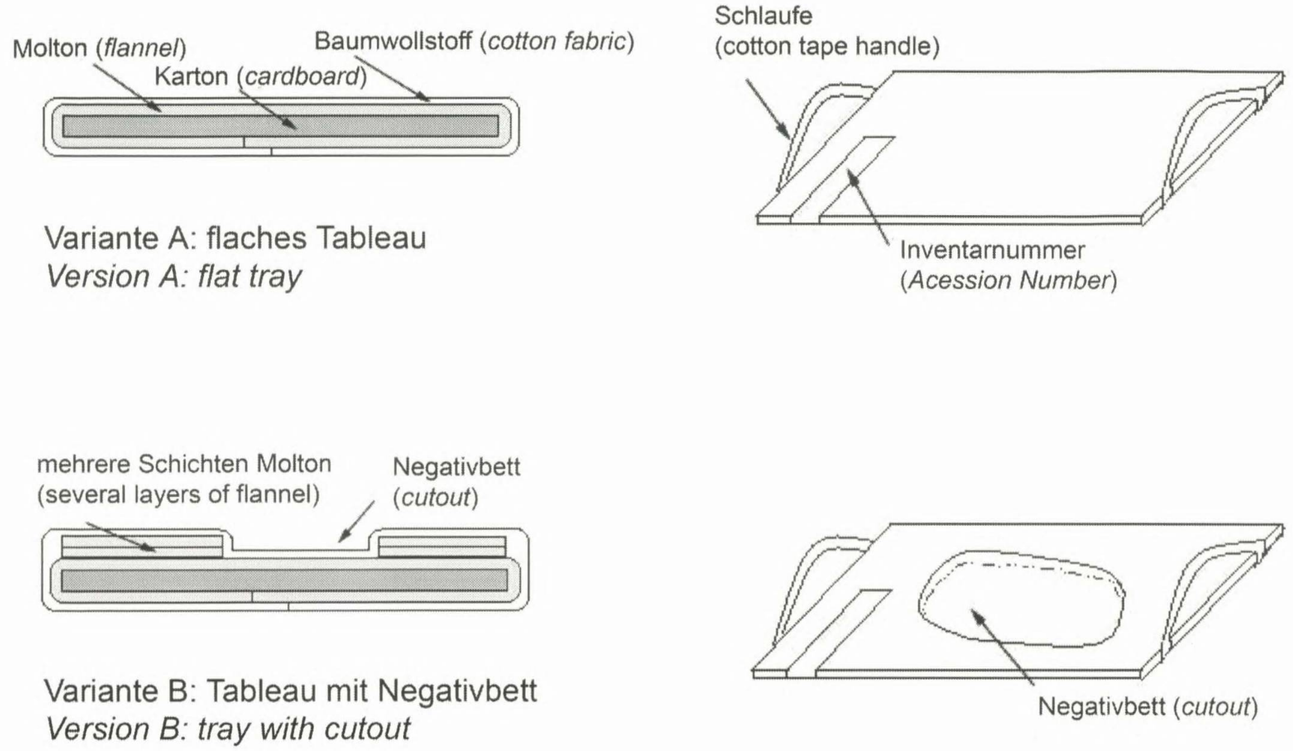
Molton (*flannel*)
Baumwollstoff (*cotton fabric*)
Karton (*cardboard*)
Variante A: flaches Tableau
Version A: flat tray
Schlaufe
(cotton tape handle)
Inventarnummer
(*Acession Number*)
mehrere Schichten Molton
(several layers of flannel)
Negativbett
(*cutout*)
Variante B: Tableau mit Negativbett
Version B: tray with cutout
Negativbett (*cutout*)

Fig. 1: Schema zum Aufbau der Tableaus der Varianten A und B (© C. Gengler).

Oberfläche, bietet jedoch ausreichende Haftung für die Textilien, sodass sie bei Bewegung, wie z. B. beim Öffnen der Schubladen oder sonstigen Handhabungen, nicht verrutschen können. Bei der Auswahl der Stoffe ist darauf geachtet worden, dass sie keine für die Objekte schädlichen Stoffe enthalten und absondern. Es wurden appreturfreie, naturbelassene und vorgewaschene Stoffe verwendet.

Aufbau

Die Stofflagen verdecken die Rückseite der Tableaus vollständig und wurden mit einem Baumwollfaden festgenäht. Das Negativbett von Variante B entstand durch Aufschichten mehrerer Lagen Molton mit einer Aussparung in der Mitte, welche sich nach Größe und Form des jeweiligen Fragmentes richtete (Fig. 1).

Funktion der Tableaus

Die Tableaus werden in bereits vorhandenen Schachteln, entsprechend ihrer Größe, aufbewahrt und in die Schubladen des metallenen Planschrankes im Tiefspeicher einsortiert. Die Schachteln bieten den Tableaus und Textilien zusätzlichen Schutz in den Schubladen und dienen als Platzhalter und Aufbewahrung für die Inventarkärtchen, falls ein Textil herausgenommen wird (Fig. 2).

An den Kanten der Tableaus wurden Baumwollschlaufen angebracht, um ein Herausnehmen aus den Schachteln zu erleichtern. So kann der direkte Kontakt mit den Textilien reduziert und eine sichere Handhabung während Untersuchungen oder Betrachtungen gewährleistet werden. Die Inventarnummer wurde mit einer Schreibmaschine auf ein Baumwollbändchen getippt, welches an der Kante des Tableaus befestigt wurde. Schlaufen und Inventarschild können bei Ausstellungen auf die Unterseite umgeschlagen werden.

In der Vertiefung von Variante B ist ein Textil auch bei langen Transportwegen vor Verrutschen gesichert. Zusätzlich bietet die Vertiefung Schutz vor Verpressungen bei der Transportverpackung.

A new concept for the storage of Textiles from Hallstatt

The new concept for storing and exhibiting the textiles consists in creating for each textile fragment an individual tray on which it will be stored, transported and exhibited. There are two kinds of trays: version A, flat trays for objects which are never exhibited; version B, trays with a cut-out which form a frame for objects which might be exhibited or travel (Fig. 1).

The trays are made of acid-free cardboard covered with a layer of heavy cotton flannel and an outer layer of untreated cotton fabric. The version B is constructed with extra

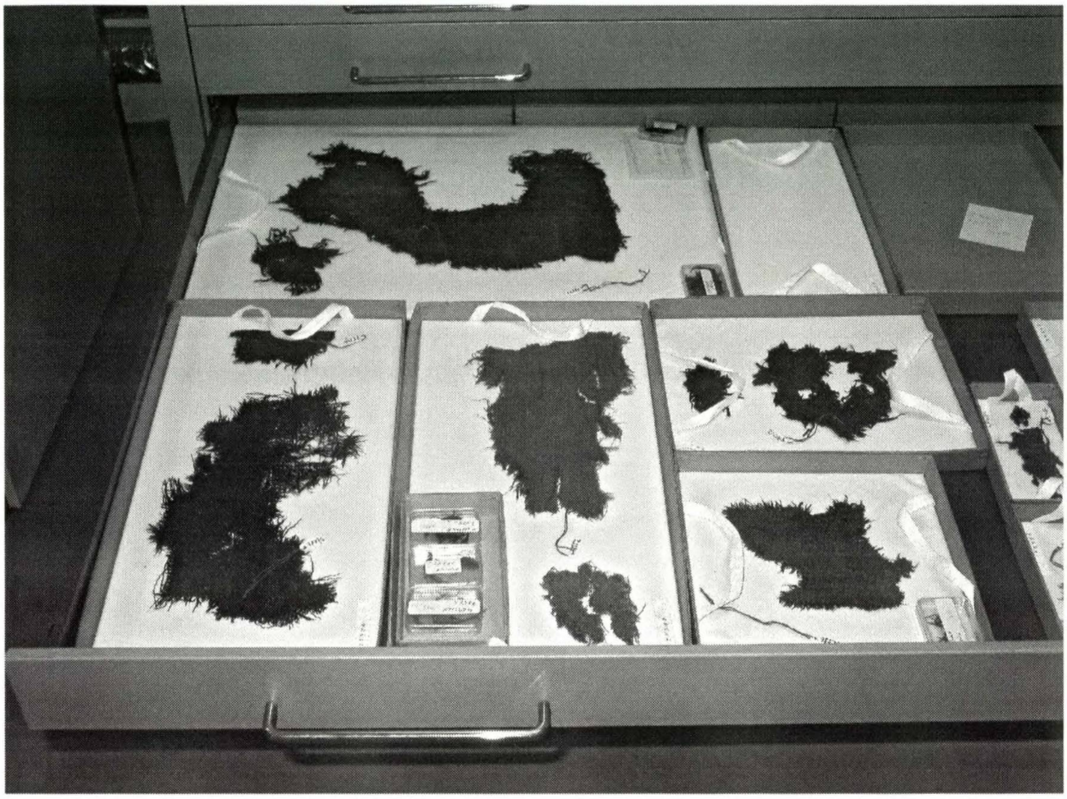

Fig. 2: Einblick in eine Schublade des Planschrankes im Tiefspeicher des Naturhistorischen Museums Wien, nach der Umlagerung der Textilien auf ihre Tableaus (© Naturhistorisches Museum Wien, Prähist. Abteilung).

layers of flannel built up to match the thickness of the object. On the sides of each board two cotton tapes are attached to facilitate lifting. The accession number is typed onto a cotton tape and affixed to the side of the tray. Both label and lifting tapes may be folded back for display. The trays are stored in boxes of matching size in the existing metal drawer unit (Fig. 2).

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Bezugsadressen der verwendeten Materialien

- Moltonflanell natur 140 cm, entschlichtet und gebeucht
- Inlett natur 140 cm 100 % Baumwolle, entschlichtet und gekocht
zu beziehen bei: Anderl & Co. Ges.m.b.H.
Weberei – Färberei – Appretur
Anderlfabrik Nr. 1
A-3943 Schrems-Kleedorf

- Museumskarton säurefrei 2,7 mm
zu beziehen bei: Nebel KG
Otto-Bauer-Gasse 4-6
A-1061 Wien

Curriculum vitae

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Tablet-woven Ribbons from the prehistoric Salt-mines at Hallstatt, Austria – results of some experiments

Karina Grömer

Abstract

The multi-coloured and richly patterned tablet-woven ribbons from the Iron Age salt-mines of Hallstatt gave the impetus to a lot of archaeological experiments. They concerned with the reconstruction of the weaving-technique, so pattern diagrams had to be prepared in order to analyse the patterns and to reconstruct them. The weaving-experiments with hand-spun woollen threads showed that the fine yarn of the original fabrics is not easy to reproduce and there is some pretreatment of the threads necessary to achieve good weaving results with tablets of various materials such as clay, wood or leather. An interesting theme is the labour requirement of the work, which can give a better understanding of prehistoric life.

Die vielfarbig gemusterten eisenzeitlichen Brettchengewebe aus dem Hallstätter Salzberg waren das Ausgangsmaterial für etliche experimentalarchäologische Versuche, bei denen es neben der Rekonstruktion der Webtechnik auch um das Erstellen einer Musterschrift zur Analyse und Nacharbeitung der Muster, sowie um Experimente zum Weben mit handgesponnenem Wollvlies ging. Hauptaugenmerk lag auf der Feinheit des bei den Originalen verwendeten Wollgarnes und seiner Handhabung beim Weben mit Brettchen aus verschiedenen Materialien. Ebenso wurden Fragen zum Arbeitsaufwand behandelt.

Introduction

The prehistoric salt-mines of Hallstatt in Austria, dating from the Bronze and Iron Ages, provide excellent conditions for the preservation of organic materials like wood, leather or textiles, woven fabrics, strings, cords and ropes. Most of the textiles were found in the Hallstatt Period mine located in the modern Kilbwerk and Kernverwässerungswerk mines. Generally they were made of wool; only a few specimens were made of flax or hemp. The threads employed are often extremely fine and of highest quality. The fabric technique is mostly twill; just a few pieces are of tabby and basket weave.

We also have bands produced in tablet-weave. Some of them display multi-coloured designs, very popular during the Early Iron Age.

The figured tablet-woven bands[1], found during the excavations carried out by the Museum of Natural History Vienna under Fritz Eckart Barth from 1989 to 1994 in the modern Kernverwässerungswerk mine, were of great interest to experimental archeologists. They date from the Hallstatt Period, the 8th to 4th Century BC.

If one goes into the details of tablet-weaving technique, many questions arise concerning specific aspects of manufacture. We will try to give some answers after having carried out some detailed analysis of fabric and weave technique.

As a basis for the reconstructions and experiments we first have to examine the original fabric specimens from Hallstatt in detail. All three of them were woven with four-hole tablets.

Ribbon No. 1

21 tablets were employed (Plate 15-16).

The warp consists of fine, well twisted woollen yarn of z-spin direction. Colours: blue-green, brownish-black and light olive-green. As an important technical detail we can state that the weft consists of horse hair. The band was used as trimming ribbon for a sleeve, sewn with paired fine blue-green yarn. It could still be seen that the ribbon once was sewn to a fabric (which is lost now) of coarse light olive plied yarn.

Pattern: at one selvedge four and on the other side two tablets with blue-green colour, then brownish-black. The background of the figures is olive-green and brownish-black. The pattern is light olive-green and displays meander and cross-filled triangles.

Width: 1.3 cm; circumference about 22 cm.

Site: Hallstatt, Kernverwässerungswerk 1990. Museum of Natural History Vienna, Inv. No. 89.832.

Ribbon No. 2

This band (Plate 15-16) has a typical Hallstatt pattern which can even be found on ceramic vessels[2] (Fig. 1). The

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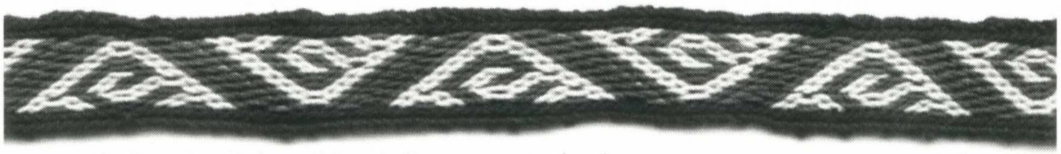
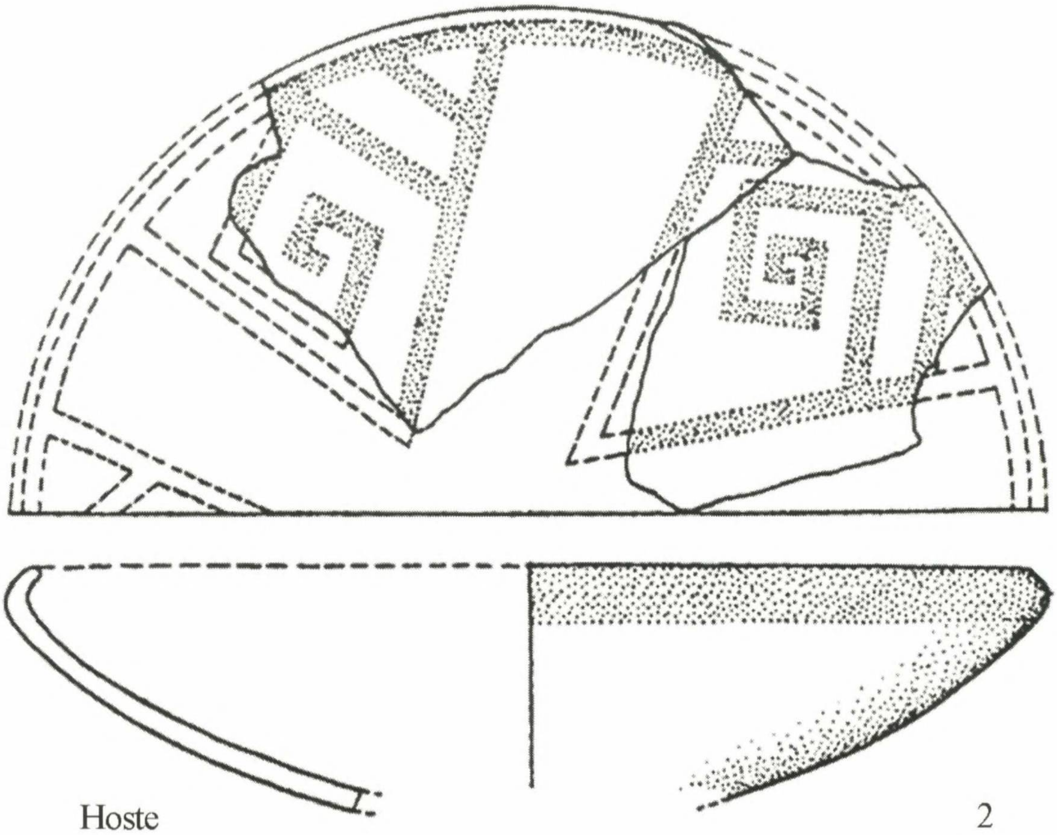
[1] After Grömer 2001: 50 f., with more details.

[2] Vessel from Hoste: Griebl 1997: Abb. 33. Another ceramic-vessel with such a pattern was found at Leobendorf: St. Nebehay, Fundber. Österreich 20, 1981: 424, Fig. 415.



Hallstatt, ribbon No. 2 (reconstruction) 1



Hoste 2

Fig. 1: Ceramic vessel from Hoste, Slovakia for comparison with the pattern of ribbon No. 2 from Hallstatt. Both Hallstatt-Period (1: © K. Grömer. – 2: based on Griebl 1997).

tape was made with 13 tablets and consists of plied wool yarn (z-twist) in warp and weft. We have two fragments of this ribbon, one has a hem sewn with dark-green plied yarn. Colours: dark-green, dark-brown, brownish-yellow, light olive-green. The weft is dark-brown.

Pattern: at each side one tablet with dark green and one with dark brown warp. The background of the figures is light olive-green and dark brown. The design consists of filled triangles in yellow.

Width: 0.9 cm; length: 8.4 cm and 5.1 cm.

Site: Hallstatt, Kernverwässerungswerk 1993. Museum of Natural History Vienna, Inv. No. 90.186

Ribbon No. 3

The third band (Plate 15) was made with 12 tablets and consists of fine s- and z-plied wool yarn employed in warp and weft. Colours: yellow, brownish-black, olive-green. The weft is blackish.

Pattern: the pattern-field is surrounded by one tablet with brownish-black threads; on one side there are two tablets with olive-green threads. On the opposite side is a single yellow thread being held by the weft. The background of the pattern is olive-green and brownish black; the pattern in yellow shows rhombs with a crossed filling.

Width: about 1.2 cm; Length: 12.5 cm.

Site: Hallstatt, Kernverwässerungswerk 1991. Museum of Natural History Vienna, Inv. No. 89.870.

It is interesting that each ribbon displays a single coloured edge and a light pattern on a dark background.

For anyone who is familiar with the practice of tablet-weaving it will be evident that these tapes were not produced in the simple basic tablet-weave, but a much more complex technique. P. Collingwood, the author of the "bible of tablet weave"[3] describes this specific technique as tablet-woven twill.

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[3] Collingwood 1982.

The technique of tablet-weaving

For the technique of tablet-weaving (Fig. 2)[4] thin square tablets were usually used. They were made of wood, bone, clay or inflexible leather, with holes in each corner.

The number and the size of the threads used for the warp determines the width of the fabric (as with other weaving techniques). It is possible to employ as many tablets as one wishes, but if more than 50 tablets are used, it is easier to weave on a loom. For the borders of the cloak from Thorsberg in Germany (transition 3rd/4th century AD) 178 tablets[5] were employed.

With this technique it was possible to produce very strong bands and ribbons. They could be used as belts, straps or as braids for the decoration of clothings.

The weaving process starts by turning the tablets a quarter circle (Fig. 3a-b). A weft thread is put through the open shed (Fig. 3c-d). The weft will not be visible in the band. The design of the finished band is only created by the differently coloured yarns which are employed as warp and pass through the holes in the tablets. The direction of the rotation of the tablets results in different patterns too. By turning the pack of tablets alternately forwards and backwards, one gets interesting designvarieties.

The tablet-woven Iron Age bands from Hallstatt display very elaborate motifs. For such patterns it is necessary not only to turn the whole pack of tablets, but single tablets have to be moved and turned in different directions before the weft goes through (Fig. 3e-f).

Experiments

Our experiments are based on three tablet-woven bands mentioned above with complicated patterns found in the Hallstatt salt-mines. Analysis revealed that the ribbons were woven using 12, 13 and 21 four-holed tablets.

During the experimental work new questions constantly turned up. In the course of the following discussion I will only refer to the most important ones.

These are the questions which concern us:

1) Preparation of pattern diagrams for the Hallstatt Period designs
2) Advantages and disadvantages of weaving with hand spun woollen threads
3) Pretreatment of the threads to achieve good weaving results
4) Comparing weaving with tablets from clay, wood and leather
5) The use of horse hair as weft
6) The labour expended

1) Pattern diagrams and analysis of the fabrics

The first step was to invent a system to transfer the patterns into a technical sketch to be able to analyse them in order to get a basis for reproduction. There exist a lot of different drawing systems for tablet-weaving. When it comes to very complex patterns, every advanced weaver employs his or her own system[6].

For us it was important to have a system from which it is evident on what part of the pattern one is working. The system for our drawing shows the appearance of the finished pattern (Fig. 4).

The pattern diagram shows the twisting direction of the warps by coloured symbols "/ " or "\ " and what the colours are, in which sequence they appear and from what side the tablets are threaded. The small arrows indicate the direction the tablets have to be turned (forwards or backwards). In the sketch each number and row of symbols represents one tablet. The first four lines show which coloured threads are passed through the four holes of each tablet (the holes are marked a-d).

The symbol placed under the pattern indicates the position of the tablets and the direction the yarns are threaded. Each line means one turning sequence, each concluded by the weft passing through. To weave one only has to turn the

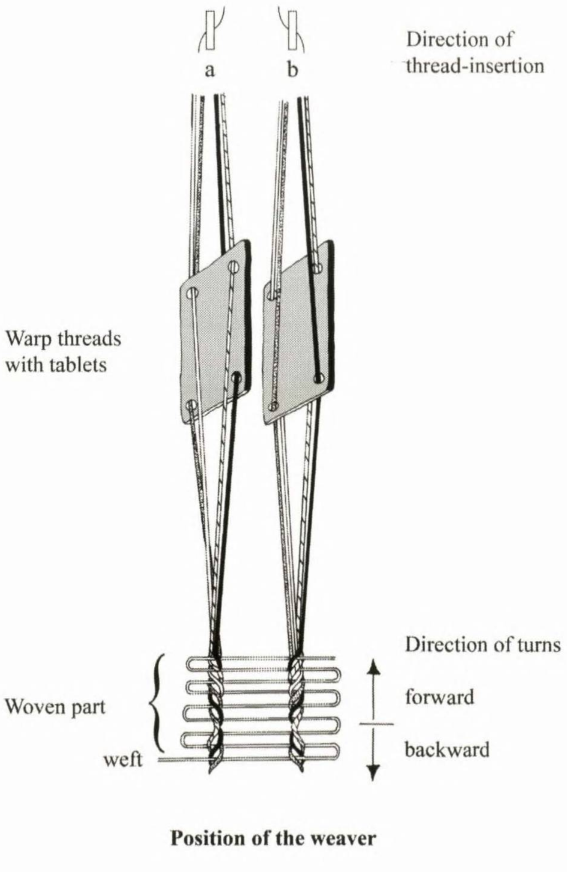

Fig. 2: Scheme of tablet-weaving (© K. Grömer).

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[4] Basic works on tablet weaving: P. Collingwood, C. Crocett, M. und H. Joliet-van den Berg, K. Schlabow und H. Stolte. See Literature.

[5] Schlabow 1965.

[6] See for example the differences between O. Staudigl, C. Crocett and Joliet van den Berg.

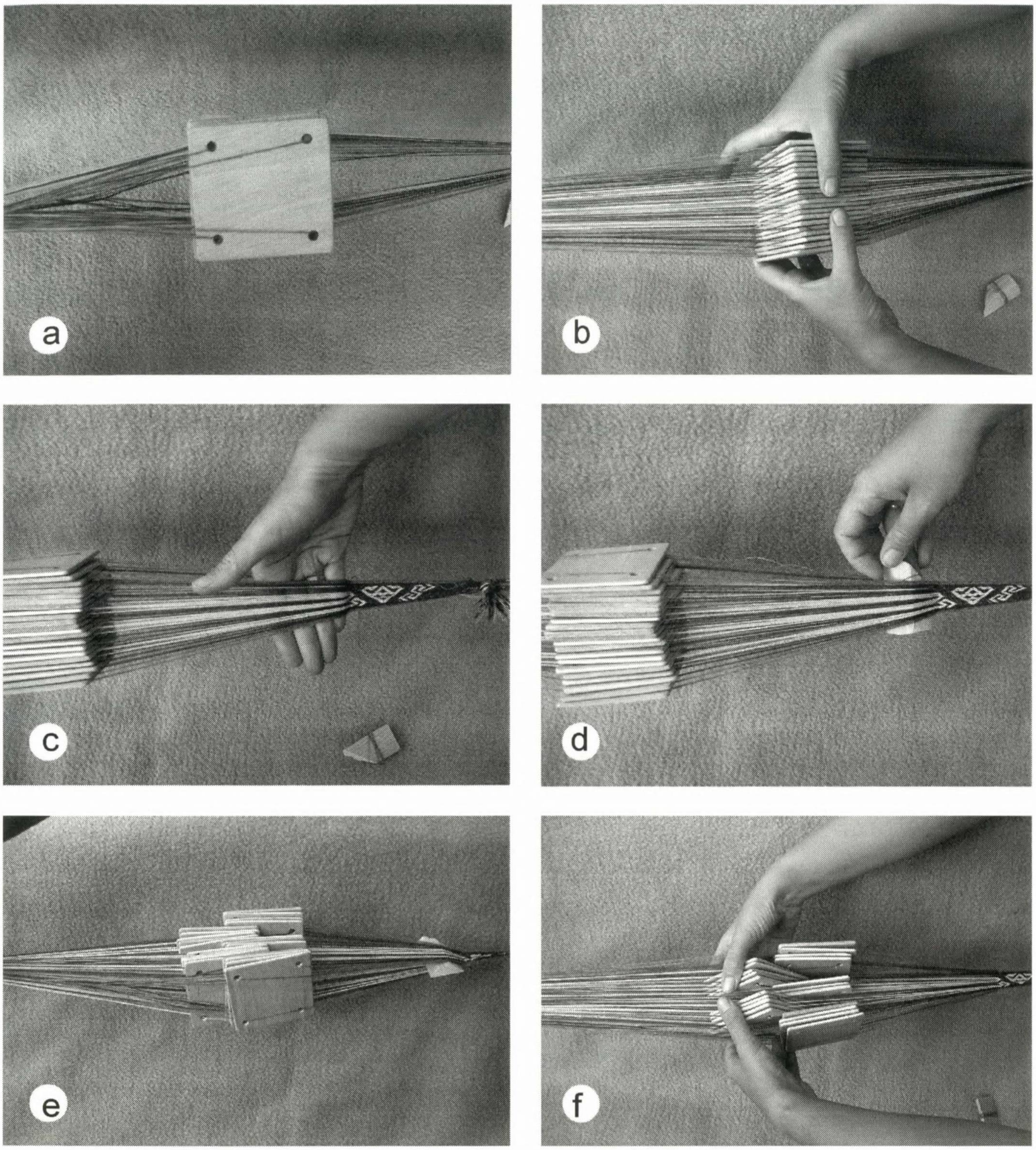

Fig. 3: Tablet-weaving: a: shed. – b: turning the tablets round a quarter. – c-d: inserting the weft through the open shed. – e-f: turning single tablets in different directions (© K. Grömer).

tablets as indicated by the scheme, either all tablets together, or variably into different directions.

Example Hallstatt-Pattern No. 3: (Fig. 4 and Plate 15) Starting with tablet No. 1, the four holes of each tablet have to be threaded with coloured warp according to the sketch. For example, all four holes of tablet 1 carries dark brown threads. Of tablet 2, hole a) carries a green, hole b) a yellow, hole c) a green and hole d) a yellow thread. All the other tablets have to be entered with threads in the same manner.

The direction of insertion of the threads is vital and has to be done as indicated by the symbols. When the tablets have been warped, they have to be set up and the warp can be tightened.

The first step is to turn forward simultaneously all the tablets (as indicated), after each pass of the weft through the shed. Four times done, this creates the first 4 lines of the

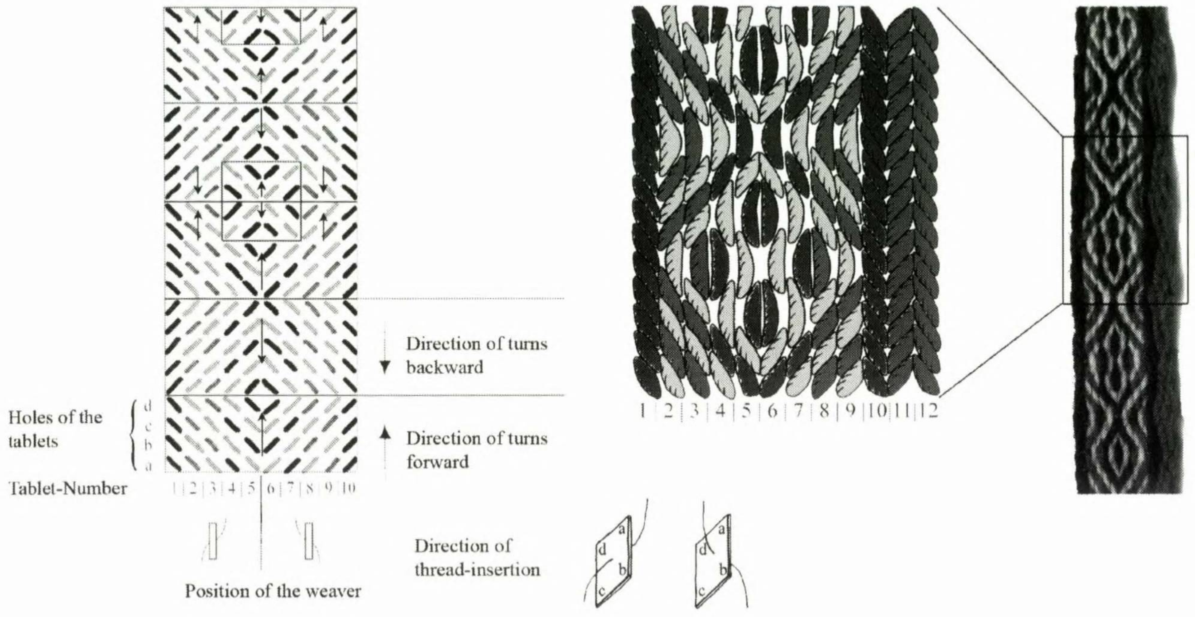

Fig. 4: Salt-mine Hallstatt: Pattern diagram and reconstructed ribbon No. 3. Compare with Plate 15 (© K. and P. Grömer).

fabric. Afterwards the tablets may only be turned in the direction indicated.

For the present example the next steps would be to turn all tablets backwards 5 times, and by this create the rhombs. Then turn three times forwards and divide the tablets into packages: tablets No. 1-3 and 8-10 are to be turned forwards, tablets No. 4-7 are turned backwards. After passing the weft the last turns have to be repeated. Then take tablet packages No. 1-3 and 8-10 and turn them backwards and tablets No. 4-7 forwards and repeated this too. Afterwards all tablets will be turned 3 times backwards to finish this Hallstatt Period pattern sequence.

Working on the reproduction of tablet-woven bands it became evident to us that the three patterns which concern us in this article are of different degrees of complexity. Ribbon No. 3 is the simplest one, No. 2 (Plate 16) is much more elaborate. Even from the draft of Ribbon No. 1 (Plate 16) the highly complicated work is evident. This is much more than the basic technique of tablet-weaving. The combination of different directions of rotation gives us an idea of the demands on concentration and three-dimensional understanding for the prehistoric weavers.

We do not know how the prehistoric people could remember such difficult patterns. In the scheme of ribbon 1 there are more than 70 different turning sequences(for the whole patternn-sequence). A modern weaver has her sketches to check every single step and so can correct mistakes in time. What method the Hallstatt people employed is unknown. Probably they formed the information into tales or songs and so handed the knowledge from one generation to the next. There is nothing we know like a drafting system for the complex Hallstatt patterns, although perhaps some abstract illustrations on pottery could be interpreted in this light. An interesting ethnographic evidence to this question is recorded from Turkey[7]. There exist „pattern books" made from felt-patches showing the insertion of the threads. Each single piece represents one tablet; coloured woollen threads were inserted with a needle into the corners to demonstrate the direction of the inserted threads and the sequence of their colour.

2) Weaving with hand-spun woollen threads

In our experiments we wanted to go beyond the simple question of how the tapes were produced in general and to move to more detailed problems.

So, in consequence, the next step after having produced the Hallstatt patterns using modern cotton yarn was to try hand-spun woollen threads as in the original bands (Fig. 5). In the following section we focus on the process of manufacture and the observations made during the experiments.

The threads of the original tablet-woven bands from Hallstatt are of very fine twisted yarn. For example ribbon No. I has 84 threads on a width of 1.3cm

The experiments showed how competent the prehistoric people were in the use of the hand-spindle. It needs well-selected wool and outstanding manual skills to produce such extremely fine yarns as were used in the Hallstatt Period. Achieving such a quality of threads with short wools is very difficult. It is vital to use only the long and finer parts of the fleece, without the coarse hair. Additionally it

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[7] Compare Kosswig 1967: 15.

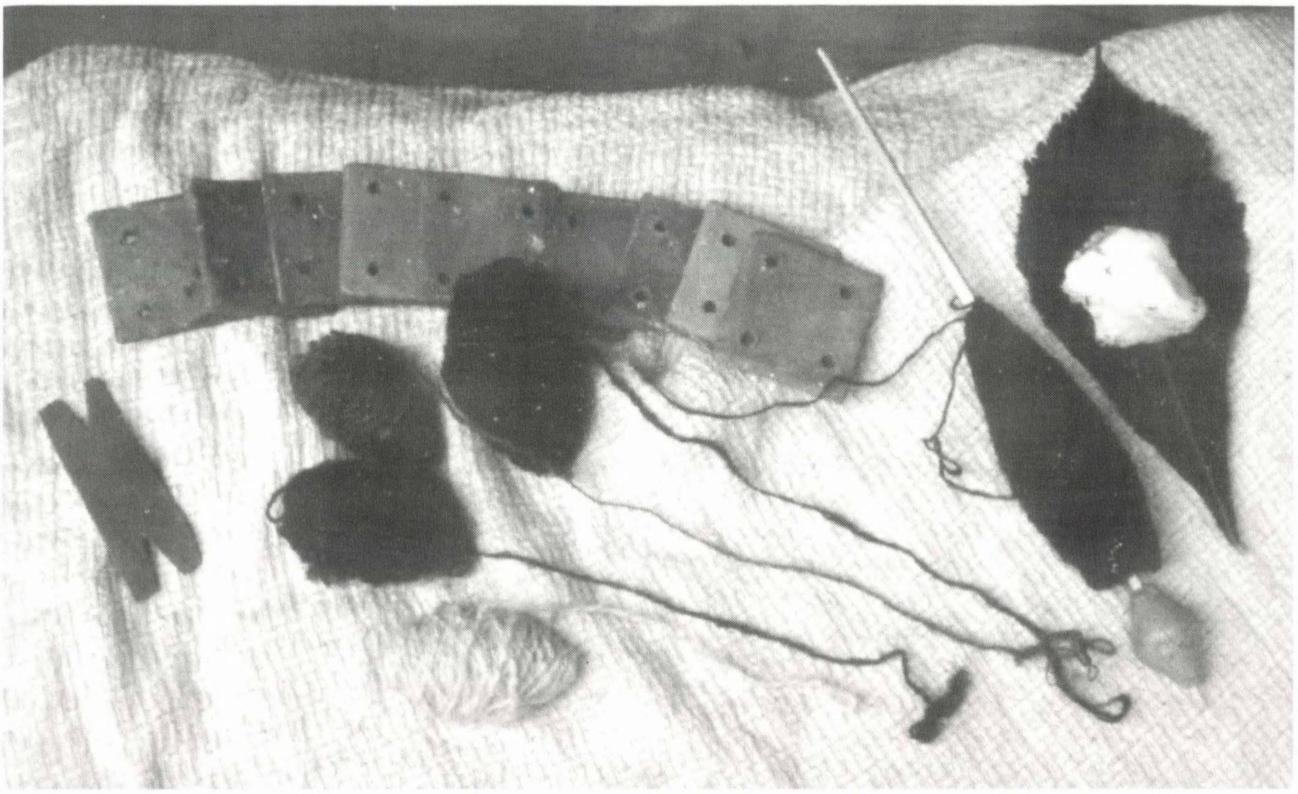

Fig. 5: Weaving-experiments: Clay tablets, tallow for sizeing and handspun woollen yarn (© K. Grömer).

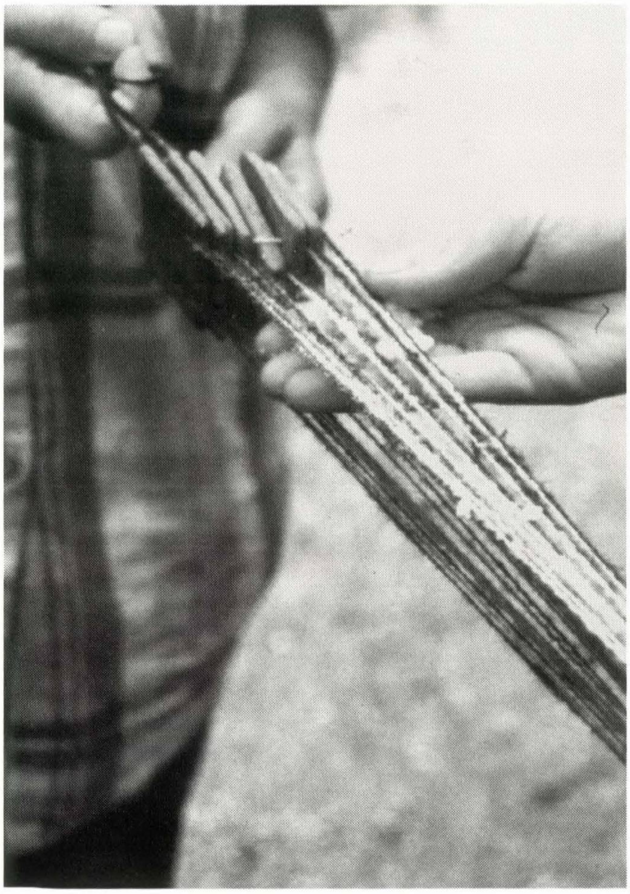

Fig. 6: Experiment: sizeing the warp with fat (tallow) (© P. Grömer).

is necessary to prepare the wool very well. Threads spun from combed wool (worsted yarn) look more similar to the original ribbon fragments than yarn from carded wool.

3) The Pretreatment of the threads

The production of threads like those used in the original ribbons is very difficult due to their extremely fine structure. It is even hard to weave with such fine yarn, for it breaks easily. The turning of the tablets affects the twisting direction of the yarns, which they acquired during the spinning or plying process (s- or z-spun or plied). The twist gets either strengthened or weakened depending on the direction in which the tablet is turned to. If a thread is weak twisted, it might untwist and break.

The experiments with hand-spun wool showed that the threads have to be overtwisted to increase their strength. If the yarns do not have enough stability, they might be untwisted and could break during the weaving process.

The threads require some special treatment to withstand the extreme conditions during the weaving process.

The problem is that overtwisted yarns easily twist with other yarns and thereby create chaos. Some experiments, and advice from an old farmer`s wife from the Upper Austrian Mühlviertel[8], showed that there are a lot of advantages in submitting the threads to a special pretreatment before weaving. The overtwisted threads were clamped on a

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[8] Friedly advice from Anna Riener, Altbäuerin from Landlgut z'Oberwinkl, Altenberg bei Linz, Upper Austria.

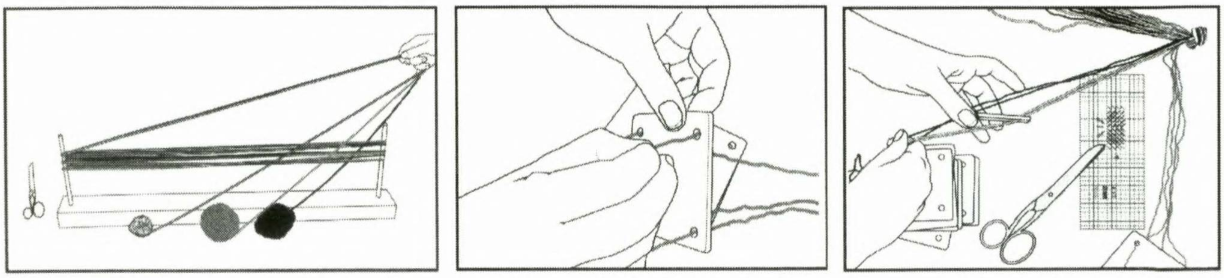

Fig. 7: Preparing the warp, method a (© N. Schörgendorfer, after K. Grömer).

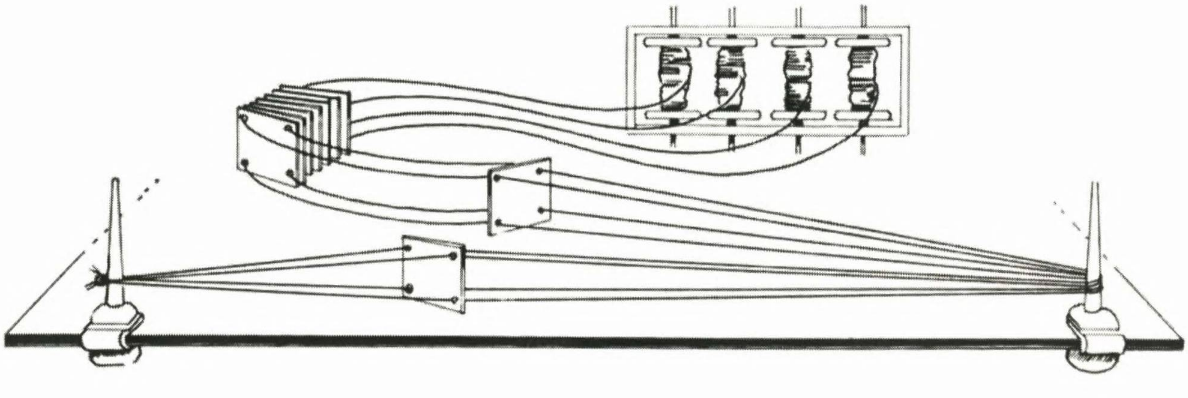

Fig. 8: Preparing the warp, method b (based on Schlabow 1957).

frame (or setting) and moistened in a tightened state. After drying the threads are more stable and they can then be used without causing tangles.

Some other experiments dealt with the pretreatment of threads to increase their resistance to wear. The threads were sized with fat (tallow) (Fig. 6). There was an improvement noticeable through the use of clay tablets, because these tablets glide much better und do not damage the warp so much. Generally the sizeing with fat was not very satisfying; for the threads became rougher than in weaving without any treatment.

4) Weaving: The use of different materials for the weaving-tablets

The next step is the preparing of the warp. There are two possibile methods:

a) If there is a complicated coloured thread-insertion necessary, the whole threads for the warp is winded off, then the yarns can be passed through the holes of the tablets individually (Fig. 7).

b) The second method for preparing the warp is to insert the thread into the whole package of tablets. In warping, the hank with the tablets is pulled and in each „row“ one tablet will be let back (Fig. 8). This method is very efficient if each tablet has threads with the same sequences of colours. Using this technique with very fine handspun yarn has a lot of advantages: there is less danger of the fine yarns getting entangled easily and breaking.

It is evident from the tablet-woven ribbons from Hallstatt that each of them could have been produced by the second warping method. This was probably intended, for this method is not so hard on the threads and much more easily carried out.

The weaving process can be started when the warp has been tied up on both ends and tightened. Weaving with hand-spun wool was tried with tablets made of wood, clay (as archaeological finds[9]) and leather (as ethnographical examples of tablets, e.g. from Nepal[10]). On principle, each of these materials work very well.

Tablets made of leather have the advantage that they are very thin. They can be handled easily, especially when weaving with many tablets, as on tape No 1 with 21 pieces. A warp with 21 thin leather-tablets can be woven even without a loom or other technical device. It is only necessary to tighten the warp between 2 fixed points. For the use of thicker tablets of clay or wood for a warp of more than 25 tablets a loom is useful.

While the wooden or clay tablets are still new, they are not wear-resistant and the threads can break (their rough surface can damage the threads leading to breakage). The behavior improves, when the tablets are used often, but by and large the material of the tablets does not have a lot of effect

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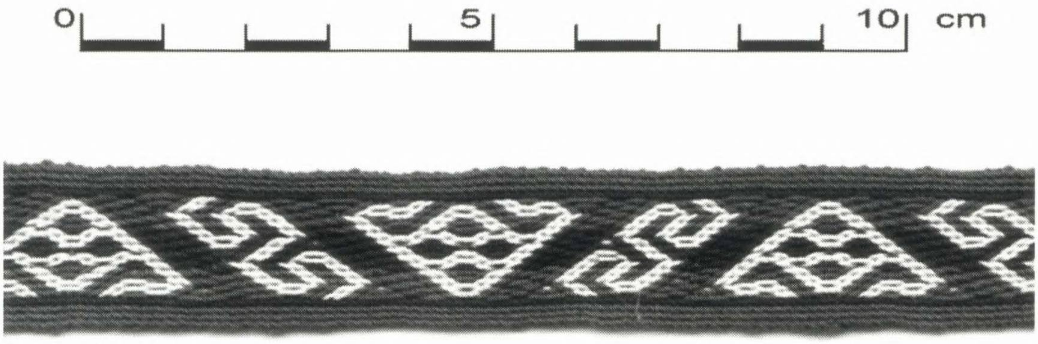
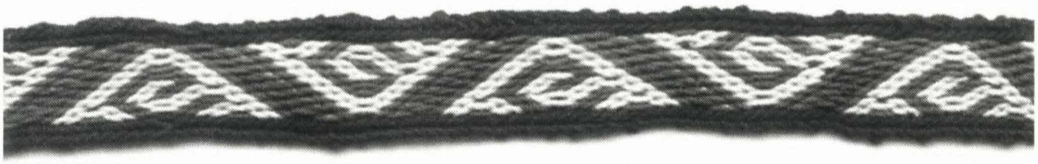
[9] More details about this: Grömer 2001: 51 f., Fig. 5.

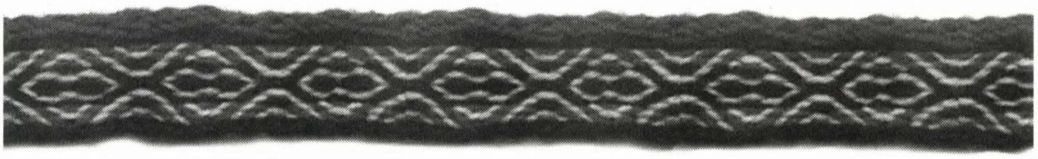
[10] Collingwood 1982: 27, Fig. 10.



Hallstatt ribbon No. 1: 1 h 30 min.



Hallstatt ribbon No. 2: 30 min.



Hallstatt ribbon No. 3: 15 min.

Fig. 9: Experiments to the expenditure of time. Comparison of the reconstructions (© K. Grömer).

on the weaving process or the finished fabric. In weaving the difficult Hallstatt patterns usually single tablets have to be turned in different directions before inserving the weft. It is useful to make small packages and turn the tablets forward or back as groups (see Fig. 3e-f). After inserting the weft, the tablets which change their direction can be moved between the forward- and back packages. Much concentration is required in order to make no mistakes.

One more observation: a good weaving result can be achieved if monochrome threads on tablets are used for lateral stripes and if they are only turned into one direction. The edge or border is very regular and the finished ribbon will not be wavy and hang badly, but it will be flat and homogeneous. As it can be seen on the ribbons from Hallstatt this advantage was noted in prehistoric times and every ribbon displays an edge with monochrome threads turned only in one direction on both sides.

5) The use of horse hair as weft

One interesting detail on ribbon No. 1 (with the multi-coloured woollen warp threads) is the use of horse hair (maybe from the mane) as weft. The long mane hair is very practical for weaving. For the experiments paired hair was inserted into the shed, overlapping with the next hair.

Horse hair is much stronger and more inflexible than wool and so generally strengthened the ribbon and made it wear resistant and inflexible (in the weft-direction). Taking horse hair for the weft of the original ribbon No 1 is practicable, because it fits very well with the intended purpose of that fabric which was as a trimming ribbon for a sleeve.

6) Time and labour

An interesting question arose during the experiments concerning the expenditure of work: how much time is needed to reproduce the patterns of the Hallstatt fabrics? Considering the patterns of tablet-woven bands from the salt-mines only theoretically will not provide any satisfactory results. The reproduction showed that the time needed for band No. 1 is three times longer than band No. 2 and 6 times longer than band No. 3 (Fig. 9). Perhaps these facts

can give us some indication of the value of the bands in prehistoric times.
For the experiments on each pattern a 1.30 m long warp was prepared. The finished ribbon is about 90 cm long, for the weaving process shrinks the length a little and the last 30 cm cannot be woven because of the tablets situated there. Time-measurements were taken at several stages in the weaving of the ribbons, so we were able to calculate averages.

Ribbon No. 1:
Made by using 21 tablets
* Preparing the warp: 8 min.
* Insertion of the threads and prepare for weaving: 30 min.
* Weaving: each sequence (about 10 cm). 1 h 30 min.

Ribbon No. 2:
Made by using 13 tablets
* Preparing the warp: 5 min.
* Insertion of the threads and prepare for weaving: 30 min.
* Weaving 10 cm: 30 min.

Ribbon No. 3:
Made by using 12 tablets
* Preparing the warp: 5 min.
* Insertion of the threads and prepare for weaving: 25 min.
* Weaving 10 cm: 15 min.

The time spent on this work clearly differs, depending on the individual practice and the deftness of the weaver. For myself I must state that after 10 years practice in tablet weaving and after having woven about 20-30 m of ribbon in each Hallstatt pattern, I think this is about the time that prehistoric people also needed for that task.

Summary of the experiments

The experiments on the tablet-woven ribbons from Hallstatt showed that, in addition to a full knowledge of the art of weaving, high skills were also demanded for producing the threads. To spin such fine threads the use of only selected and well prepared wools and special finger skill is necessary. In order for the yarns to withstand considerable strain, especially during the tablet-weaving, they have to undergo special treatment in advance. In spinning the threads have to be strongly overtwisted and moistened to give them extra strength and to prevent them from disintegrating during tablet-weaving where they might become loose and tear.
Experiments to treat the threads with grease did not prove satisfactory, for the threads were rougher than when in a dry condition. The experiments in that case have to go on.
The material employed for the tablets (terra cotta, leather or wood) has no great effect on the process of weaving or on the finished band. The combination of tablets being turned forwards and backwards for each weft shot demands the ability to think three dimensionally and concentrate hard.

Experimentalarchäologische Rekonstruktion der Brettchenwebereien aus dem Salzbergwerk in Hallstatt

Die uns hier interessierenden Funde, die gemusterten Brettchengewebe, stammen aus dem hallstattzeitlichen Kernverwässerungswerk (8.-4. Jahrhundert v. Chr.) und wurden bei den Ausgrabungen des Naturhistorischen Museums in Wien unter Fritz Eckart Barth in den Jahren 1989-1994 zutage gefördert.
Als Webgerät dienen bei dieser Technik großteils quadratische, an den Ecken gelochte Brettchen aus Holz, Knochen, Ton oder steifem Leder. Es wurden meist schmale Gewebe hergestellt, die wegen ihrer Haltbarkeit und Zugfestigkeit für praktische Zwecke genutzt wurden, beispielsweise als Tragegurte oder auch als Borten und Gürteln.
Beim Brettchenweben wird das Webfach gebildet, indem die Brettchen um je eine Vierteldrehung gedreht werden. Der Schussfaden, der durch das so entstandene Fach geführt wird, ist im Gewebe selbst nicht sichtbar. Je nachdem, in welcher Kombination färbige Fäden bei der Kette verwendet werden, sind vielfältige Musterungen möglich. Die Drehrichtung der Brettchen bietet eine weitere Möglichkeit der Motivgestaltung. Dreht man abwechselnd vor und zurück, ergeben sich bei entsprechender Bespannung Zickzack- oder Rautenmuster.
Für kompliziertere Motive – wie die eisenzeitlichen Brettchenborten aus Hallstatt – muss man in einem Arbeitsvorgang einzelne Brettchen nach vor, und andere zurück drehen, bevor der Schussfaden durchgeführt wird.
Für die Experimente wurden von den Hallstätter Textilresten drei Brettchengewebe mit komplizierten Mustern herausgegriffen.
Durch die Analyse wurde festgestellt, dass die Borten mit 12, 13 bzw. 21 vierlöchrigen Brettchen gewebt wurden. Zunächst galt es, für die hallstattzeitlichen Brettchengewebe ein Aufzeichnungssystem zu schaffen, um die Muster analysieren und nacharbeiten zu können.
Die Nacharbeitung ergab, dass die Muster verschiedene Schwierigkeitsgrade hatten. Auch im Webschema ist zu sehen, dass das Motiv von Borte 1 am kompliziertesten war, weit entfernt von der einfachen Grunddrehdynamik beim Brettchenweben. Die Kombination von verschiedenen vor- und rückwärts gedrehten Brettchen bei einem Schuss zeugt vom großen räumlichen Verständnis und von der Konzentrationskraft der oder des Ausführenden.
Als nächster Schritt nach der Nachvollziehung der Motive mit leicht zu verarbeitenden modernen Baumwollgarnen ergaben sich Fragestellungen zum Weben mit handgesponnenem Wollgarn, aus welchem in der Hallstattzeit auch die Originale gefertigt wurden.
Die Experimente rund um die Brettchenborten aus Hallstatt haben insgesamt gezeigt, dass neben der handwerklich perfekten Ausübung der Weberei auch den Personen einiges abverlangt wurde, die die Fäden hergestellt haben. Es erfordert sehr gute Fingerfertigkeit und die Verwendung ausgesuchter Wolle, um so feine Fäden spinnen zu können. Dass die Garne (Zwirne) den extremen Belastun-

gen besonders beim Brettchenweben standhalten, bedürfen sie besonderer Behandlung.

Die Fäden der originalen Brettchengewebe sind sehr fein (bei Borte 1 sind es 84 Fäden auf 1,3 cm Breite), es handelt sich um feinen, scharf gedrehten Zwirn. Versuche mit handgesponnener Wolle ergaben, dass die Fäden beim Spinnen sehr stark überdreht und anschließend gewässert werden müssen, um ihnen besondere Festigkeit zu verleihen und dem Umstand vorzubeugen, dass sich die Fäden beim Brettchenweben wieder aufdrehen und dadurch locker werden. Eine Gefahr ist auch, dass sie durch das Scheuern der Brettchen während des Webvorganges reißen.

Versuche zum Behandeln der Fäden mit Fett (Rindertalg) waren nicht sehr zufriedenstellend, da die Fäden mehr aufgerauht werden, als beim „Trocken weben“. Die Webproben mit handgesponnener Wolle wurden nach den archäologischen Belegen mit Holz- und Keramikbrettchen, sowie nach völkerkundlichen Hinweisen mit Lederbrettchen durchgeführt. Als Ergebnis kann angemerkt werden, dass das Material der Brettchen keinerlei große Auswirkung auf das Weben oder das fertige Gewebe hat, es ist am Gewebe selbst nicht zu sehen, welches Brettchenmaterial verwendet wurde.

Eine andere Fragestellung bei den Experimenten behandelte den Arbeitsaufwand; wieviel Zeit benötigt wurde, um die einzelnen Borten herzustellen. Dabei ergab sich die durch reine theoretische Betrachtung der Muster nicht erkennbare Tatsache, dass für das Weben von Borte 1 fast 3x soviel Zeit wie für Borte 2 und mehr als 6x soviel Zeit wie für Borte 3 benötigt wurde. Dies kann möglicherweise auch ein Schlüssel dafür sein, wie „kostbar“ die einzelnen Borten in der damaligen Zeit waren.

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Homepage of the author with information about textile techniques (archaeological) in general and a lot of patterns for tablet-weaving.

http://www.steinmaus.de/Mittelalter/weben
Website with good and detailed descriptions of tablet-weaving. Of special interest are the links to over 40 Webpages concerning tablet-weaving from different countries.

http://home.t-online.de/home/kfm.laitenberger/
Page with tablet weaving plant dyes and other weaving techniques. On this webpage you can find a study-course about tablet-weaving with a lot of examples and links to other webpages.

Curriculum vitae

Born in Linz, Austria, 1974, study at the Department for Pre- and Protohistory of the University Vienna (Mag. phil. 1999). Editor of the periodical "*Archäologie Österreichs*" of the Austrian Society for Pre- and Protohistory. Main interests and projects are the Stone Age (Neolithic), Experimental Archaeology, prehistoric textiles.

Current projects: The Bronze Age textiles from the Christian-Tuschwerk at the saltmines from Hallstatt, Austria in comparison with the Hallstatt Age fabrics (Dissertation).

— Analysis of artefacts from Hallstatt, experiments and reconstructions of prehistoric textile techniques (spinning, tablet-weaving ...).

Imitating ancient dyeing methods from the Hallstatt period – dyeing experiments with weld, indigo and oak bark

Anna Hartl and Regina Hofmann-de Keijzer

Abstract

Based on dyestuff analysis of prehistoric textile finds (Hallstatt, 800-400 B.C.), dyeing methods with dye plants were developed which possibly could have been used in the Hallstatt period and which meet the requirements of modern analytical technology. The essential elements of traditional dyeing procedures were worked out and carried out with standardized test materials and standardized dyeing methods.

Basierend auf den Ergebnissen der Farbstoffanalyse von prähistorischen Textilfunden (Hallstatt, 800-400 v.Chr.) wurden Färbemethoden mit Pflanzenfarben entwickelt, die für die Hallstattzeit historisch denkbar sind und auch den Anforderungen der modernen Analytik entsprechen. Die für die Fragestellung wesentlichen Elemente der traditionellen Färbeverfahren wurden herausgearbeitet und auf standardisiertem Material mit standardisierten Verfahren durchgeführt.

Dyeing experiments in relation to Hallstatt textile research

The results of the project *Halltex 1*[1] showed that the textiles from the prehistoric salt-mines of Hallstatt in Upper Austria were dyed with plant and insect dyes. In most of the analysed textiles the element copper was detected.

There are two possible explanations for the origin of the copper:

* the use of copper-containing mordants (i.e. substances to fix the colour on the fibre) in the ancient dyeing process and/or

* the conditions under which the textile pieces were embedded in the "heathen's rock" (*Heidengebirge*).

In the area where the textiles were found, natural-copper containing salt-rock can be excluded, so the broken-off tips of bronze picks of the Hallstatt period (800-400 BC) which are found in the "*Heidengebirge*" are supposed to be the source of the copper.

A research project was started to find out how different mordanting and dyeing methods as well as the embedding conditions in the "*Heidengebirge*" influence the copper content in the textiles. Wool samples were dyed with plant dyes in Hallstatt in September 2003 and half of them were buried in the salt-mine in Hallstatt. Analysis of copper and dyestuff content before and after the embedding in the salt will enable conclusions to be drawn about the determining parameters. Analytical results are not yet available, because the samples are still buried in the mine. This article therefore focuses on the development of the dyeing methods, the description of the experiments and – as preliminary results of the dyeing experiments – the colours which have been achieved.

Development of dyeing methods

Selection of materials based on analytical results of prehistoric Hallstatt textiles

Our choice of dyeplants and mordants for the dyeing experiments was based on the analytical results of *Halltex 1*. We chose weld (*Reseda luteola*) because the dyestuffs luteolin and apigenin were identified in the original textiles. Weld can be used for dyeing yellow as well as green, by overdyeing blue dyed material with weld. These green dyes were also found in Hallstatt textiles: in some of the textiles analysed the dyestuffs luteolin and apigenin were identified together with indigotin.

The tannins which were found in the Hallstatt textiles can originate from various tannin-containing plants. From the analytical results it was clear that tannins were used, but it is analytically not possible to identify which tannin it was. We chose oak bark (*Quercus sp.*) for the experiments. Depending on the mordants, oak bark can be used for creating a light brown to a dark brown, almost black colour.

In the context of the textile finds, the presence of the pigment indigotin leads to the presumption that woad (*Isatis tinctoria*) was used. Woad was used for colouring blue before indigo gained from the subtropical indigo plant species *Indigofera sp.* was imported. For the experiments, the subtropical indigo was used instead of woad indigo, because it is easier to standardize (see below).

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[1] Hofmann-de Keijzer, R., van Bommel, M.R., Joosten, I. 2005: Ancient colours – recent knowledge. Dyestuff and element analysis on textiles from the prehistoric salt-mine of Hallstatt, in this volume.

Table 1: Simplifying the dyeing procedures for the development of standardized dyeing methods (© A. Hartl).

Selection of materials based on analytical results of prehistoric Hallstatt textiles (Hofmann-de Keijzer et al. 2004) ⇨	**Traditional rural dyeing procedures using this components** ⇨	**Simplification of procedures for the dyeing experiments**
Dyestuff analysed: tannins ⇨ dye plant: several tannin containing species Elements analysed: iron ⇨ mordant: iron salts	Procedures for dyeing black (Bielenstein 1935, Mautner and Geramb 1932) using tannin containing dye plants (e.g. oak and alder bark, alder cones, nut shells, gallnuts) and natural mordants (iron containing mire water and mud; iron containing grinding sludge; "Eisenschrottlauge" – a mixture of rusty iron, sour thin beer ("saures Dünnbier") and grinding sludge)	Use of one dye plant (oak bark) instead of a mixture of different dye plant species to reduce parameters. Use of iron(II) acetate instead of natural mordants to be able to define the amount of mordant and to exclude impurities containing other metals. ⇨ **Dyeing with oak bark and iron(II) acetate**
Dyestuff analysed: indigotin ⇨ dye plant: woad (?)	Fermenting vat with woad (Bielenstein 1935)	A hydrosulfite* vat with indigo from *Indigofera sp.* was used (instead of fermenting vat) because this procedure is easier to handle and does not take so much time. For our research question the type of vat dyeing was not relevant. ⇨ **Dyeing with indigo (hydrosulfite vat)** Beside the analytical program, first to gain experience with fermenting vat, an experiment with urine vat was carried out successfully (Plate 17); procedure adapted according to Fischer 1999.
Dyestuff analysed: luteolin, apigenin ⇨ dye plant: weld Elements analysed: copper, iron ⇨ mordant: copper and iron salts	Dyeing in metal kettles or putting pieces of metal and metal cuttings into non-metallic dye pots or dye pits. Use of natural acids (e.g. whey, sauerkraut juice). Scouring of the metallic surface of the kettle to enable reaction between acid and metall (= metal salt). (Bielenstein 1935)	Dyeing in a glass beaker and use of copperacetate (copper salt of acetic acid) instead of metal kettles or pieces of metal, to be able to define exactly the amount of mordant and to be able to exclude impurities containing other metals. ⇨ **Dyeing with weld (copper(II) acetate and iron(II) acetate)**
Dyestuff analysed: luteolin, apigenin ⇨ dye plant: weld Elements analysed: copper ⇨ mordant: copper salts	Dyeing by fermenting wool and dye plants with bread, yeast, sourdough, flour or porridge. (Bielenstein 1935)	**Dyeing with weld and yeast** The dyeing method is based on information given by Klempau (1991) who did experiments with fermenting dyeing and also refers to Bielenstein (1935). **Dyeing with weld and yeast and copper (copper sheet metal and copper pot)** This variants should show the mordanting effect of a metallic dye kettle produced by the acid which is built during the fermenting process. It was planned to use glass beakers with copper sheet metal inside instead of copper kettles to have exactly the same copper alloy. Only for one dyeing a copper kettle should have been used.

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*) Sodium hydrosulfite is the common commercial name for products containing sodium dithionite, $Na_2S_2O_4$, as the active ingredient and is used as a reducing agent for indigotin.

	Material	Method
Dyeing with oak bark and iron(II) acetate	For 50 g white wool: 150 g oak bark, 0.625 g Fe-acetate, 24 l demineralized water*. Same for 50 g brown wool	Mordant dyeing (table 3)
Dyeing with indigo (hydrosulfite vat)	For 50 g white wool: 1 g indigo, 1.3 ml sodium hydroxide (33%), 1.5 g and 1 g sodium dithionite (sodium hydrosulfite, 87%), 1 ml ammonia (25%), 1 drop of mild washing detergent, 20 l demineralized water*. Same for 50 g brown wool	Vat dyeing (table 4)
Dyeing with weld and copper(II) acetate	For 20 g white wool: 60 g weld, 0.29 g Cu-acetate, 15 l demineralized water*. Same for: 20 g brown wool 20 g indigo dyed white and 20 g indigo dyed brown wool 20 g oak bark dyed white and 20 g oak bark dyed brown wool	Mordant dyeing (table 3)
Dyeing with weld and iron(II)-acetate	For 20 g white wool: 60 g weld, 0.25 g Fe-acetate, 15 l demineralized water*. Same for: 20 g brown wool 20 g indigo dyed white and 20 g indigo dyed brown wool 20 g oak bark dyed white and 20 g oak bark dyed brown wool	Mordant dyeing (table 3)
Dyeing with weld and yeast	For 20 g white wool: 60 g weld, 40 g (80 g)** yeast, 10 g honey, 12.5 l demineralized water* Same for: 20 g brown wool 20 g indigo dyed white and 20 g indigo dyed brown wool 20 g oak bark dyed white and 20 g oak bark dyed brown wool	Dyeing procedure with yeast (table 4)

*) including water for washing

**) only 2 pre-tests were carried out: one with 40 g yeast, one with 80 g yeast

Table 2: Dyeing procedures – overview (© A. Hartl).

Element analysis of the Hallstatt textiles show copper and iron ions. The conclusion could therefore be drawn that copper and iron salts could have been used as mordants.

All Hallstatt textile finds from the period of 800-400 BC are made of sheep's wool; white as well as naturally coloured brown wool was used. Even the naturally brown wool was dyed. We chose therefore white and brown Merino wool for the experiments.

Little knowledge of ancient dyeing procedures ...

Little is known about the dyeing procedures from such early periods of time as the Hallstatt period. In the best cases there is evidence of dyestuffs or evidence of substances which lead to the conclusion that they were used as mordants or dye assistants. Sources of that knowledge are dyestuff analysis of textile finds[2] and analysis of substances found in pots situated in building structures on Crete and Cyprus and in Palestine which are interpreted as dye-workshops[3].

Because of this lack of knowledge about ancient dyeing procedures, ideas for dyeing methods were taken from documents on traditional rural dyeing procedures which were still practised in the 19th and early 20th century in Latvia[4] and Slovenia[5].

Simplification of procedures for the dyeing experiments

The dyeing experiments should combine dyeing procedures which possibly could have been used in the Hallstatt period with the requirements of modern analytical methods. To avoid non-definable influences, we decided to develop standardized dyeing procedures, which imitate traditional procedures under laboratory conditions: e.g. we chose iron(II) acetate as mordant instead of dyeing with natural acids and pieces of metal; we chose indigo obtained from the subtropical indigo plant *Indigofera sp.* instead of woad indigo, because this indigo is better available and the dyeing process (hydrosulfite vat[6]) is shorter and easier to standardize.

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[2] E.g. for the Hallstatt period: Banck-Burgess 1998a: 18-21. – Banck-Burgess 1998b: 30-31. – Banck-Burgess 1999.

[3] Barber 1992.

[4] Bielenstein 1935.

[5] Mautner and Geramb 1932: 76-79.

[6] Sodium hydrosulfite is the common commercial name for products containing sodium dithionite, $Na_2S_2O_4$, as the active ingredient and is used as a reducing agent for indigotin.

Dyeing solution	mix dyeing material with demineralized water soak (oak bark for 48 hours, weld for 10 hours) filter off boil (oak bark for 5:15 hours, weld for 1 hour) fill up evaporated water
Mordanting	dissolve mordant in demineralized water put wet wool in heat slowly, boil for 1 hour let it cool down
Dyeing	put wool in dyeing solution heat slowly, boil for 1 hour let it cool down
Washing	4 times in demineralized water

Table 3: Mordant dyeing (© A. Hartl).

To achieve a broader basis for the analysis, dyeing procedures with copper mordant and iron mordant as well as overdyeing of dyed wool were chosen (it is supposed that there are mutual effects between iron and copper). To have one sample dyed without any mordant at all, we tried a dyeing procedure using yeast. The use of fermenting substances like yeast, sauerdough, porridge etc. for dyeing procedures without metal mordants and without boiling was documented by M. Bielenstein[7] for traditional rural dyeing methods in Latvia. Experiments with fermenting dyeing methods were also carried out by I. Klempau[8].
To colour the wool sufficiently, the quantity of dye plants and mordants was inspired by modern dyeing descriptions[9]. The development of dyeing methods is described in table 1.

Description of dyeing methods

Material

Raw white and brown Merino wool was washed without detergents, only with demineralized water at 50°C, to avoid non-definable influences of washing detergents, bleaching chemicals, etc. According to G. P. Sjöberg[10], about 80 % of wool fat and dirt is dissolved by just using warm water. Weld and oak bark were used cut into pieces, indigo from the subtropical indigo plant species *Indigofera sp.* was used pulverized. For mordants and chemicals see table 2.

Method

The dyeing methods are described in table 2-5. White and brown wool was dyed in separate glass beakers at the same time. Temperature and pH-value of the dyeing solution and the mordanting solution were documented.
Beside the single dyeings of white and brown wool with oak bark, indigo and weld, overdyeings were also carried out: indigo-dyed and oak bark-dyed wool was overdyed with weld (using copper acetate respectively and iron acetate as mordant).
Unfortunately the pre-test dyeing with weld and yeast (table 5) did not work adequately: it took too long until the fermenting started and the wool was not coloured enough (although the treatment was extended for seven days and honey was added on the third day to improve fermenting). So we had to stop the experiments with yeast and chose a sample of washed but undyed wool as control sample . An overview of the samples is given in table 6. For more detailed description of the dyeing methods see also the final report of the experiments[11].

Preliminary results

The colours which were achieved (Plate 17) look similar to those of Hallstatt textiles, especially the yellow-olive green shades. The blue of the indigo dyeing is much lighter than the blue found in Hallstatt textiles, but darker shades can be achieved by a higher indigo concentration in the vat and by carrying out more than one dipping.
Analytical results are not available yet because half of the samples are still buried in the salt-mine in Hallstatt since October 2003. After a certain time – still to be discussed – these samples will be compared with the samples which were not embedded in the salt, using:

- visual technique
- light microscopy
- Scanning Electron Microscopy (SEM)
- Scanning Electron Microscopy with Energy Dispersive X-ray microanalysis (SEM-EDS) and
- High Performance Liquid Chromatography coupled to Photo Diode Array detection (HPLC-PDA).

The aim of this research is to find out the influences of the mine on the textiles in respect of the colours, the dyestuffs and the metal elements.

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[7] Bielenstein 1935.

[8] Klempau 1991: 361-363.

[9] Bächi-Nussbaumer 1980. – Fischer 1999. – Hofmann-de Kejizer 2002.

[10] Sjöberg 1997.

[11] Hartl 2003.

Preparation of the stock vat (preliminary indigo vat)	premix indigo with 5 ml demineralized water and mild washing agent add 25 ml demineralized water, add sodium hydroxide and 1.5 g sodium hydrosulfite, stir up keep stock vat at 50-55 °C in a water bath for 20 min.
Preparation of the indigo vat	heat 4 l demineralized water up to 50-55 °C add ammonia and 1 g sodium hydrosulfite , stir up pour the stock vat in (avoiding contact with the oxygen in the air!) skim off the flower
Dyeing	put wet wool into the vat and keep temperature not below 50 °C take wool off after 30 min. let it become blue for 30 min.
Washing	4 times in demineralized water

Table 4: Vat dyeing (© A. Hartl).

Summary

The results of the research project *Halltex 1* showed that the textiles from the prehistoric salt-mine of Hallstatt in Upper Austria were dyed with plant and insect dyes. In most of the textiles analysed the element copper was detected. Possible copper sources are copper-containing mordants used in the ancient dyeing processes and/or the conditions under which the textile fragments were embedded in the heathen´s rock ("*Heidengebirge*").
To find out how different mordanting and dyeing methods as well as the embedding conditions in the *Heidengebirge* influenced the copper content in textiles, wool samples were dyed with plant dyes and buried in the *Heidengebirge*. Analysis of the copper content before and after the embedding in the salt will enable conclusions to be made about the determining parameters. Dyeing methods with dye plants were developed, which are based on the dyestuff analysis of the textile finds, which possibly could have been used in the Hallstatt period and which meet the requirements of modern analytical technology.
The essential elements of traditional dyeing procedures were worked out and carried out with standardized test materials and standardized dyeing methods. Mordant dyeing methods with weld (*Reseda luteola*) and oak bark (*Quercus sp.*), mordanted with iron and copper acetate, and indigo dyeing (*Indigofera sp.*) using a hydrosulfite vat were carried out on white and naturally pigmented brown Merino sheep wool. Overdyeings were also done to achieve a broader basis for the following analysis.

Nachempfindung alter Färbemethoden aus der Hallstattzeit – Färbeexperimente mit Färberwau, Indigo und Eichenrinde

Die Resultate des Forschungsprojekts *Halltex 1* zeigten, dass die aus dem prähistorischen Salzbergbau Hallstatt in Oberösterreich stammenden Textilien mit Pflanzen- und Insektenfarbstoffen gefärbt worden sind. In den meisten der analysierten Textilien wurde Kupfer nachgewiesen. Als mögliche Kupferquellen kommen die Verwendung von kupferhältigen Beizen im Färbeprozess und/oder die Lagerungsbedingungen im Berg in Frage.
Durch Färbeexperimente, Einlagern der Proben im Heidengebirge und vergleichende Analysen soll herausgefunden werden, welchen Einfluss die Verwendung verschiedener Beiz- und Färbeverfahren sowie die Lagerungsbedingungen auf die Kupfergehalte in den Textilien haben. Es wurden Färbemethoden mit Pflanzenfarben entwickelt, die auf den Ergebnissen der Farbstoffanalyse der Originalfunde basieren, für die Hallstattzeit historisch denkbar sind und auch den Anforderungen der Analytik entsprechen: die für die Fragestellung wesentlichen Elemente der traditionellen Färbeverfahren wurden herausgearbeitet und auf standardisiertem Material mit standardisierten Verfahren durchgeführt. Dazu wurden Beizenfärbungen mit Färberwau (*Reseda luteola*) und Eichenrinde (*Quercus sp.*) mit Eisen- und Kupferacetatbeize sowie

Dyeing solution	pour boiling demineralized water on weld soak for 13:15 hours filter off
Dyeing	dissolve yeast in the dyeing solution add wet wool keep at 30 °C in the drying cupboard for 3 x 24 hours
Washing	4 times in demineralized water

Table 5: Dyeing procedure with yeast (© A. Hartl).

Method	**Material which is dyed:**		
	White and brown wool	Indigo dyed white and brown wool	Oak bark dyed white and brown wool
Washed raw wool*	x		
Dyeing with oak bark and iron(II) acetate	x		
Dyeing with indigo (hydrosulfite-vat)	x		
Dyeing with weld and copper(II) acetate	x	x	x
Dyeing with weld and iron(II) acetate	x	x	x

*) because the dyeing with yeast did not work, we chose a sample of washed wool as control sample

Table 6: Overview of samples (© A. Hartl).

Indigofärbungen (*Indigofera sp.*) mit einer Hydrosulfitküpe auf weißem und naturbraunem Merinowollvlies durchgeführt. Es wurden auch Überfärbungen gemacht, um eine breitere Basis für die nachfolgenden Analysen zu erzielen.

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Curricula vitae

Anna Hartl was research assistant at the Institute of Organic Farming, University for Natural Resources and Applied Life Sciences Vienna (1997–1999). Since 2000 she has been a freelance researcher. She did research projects on fibre and dye plants for use in eco-textiles, agricultural field trials with fibre nettle and dye plant species and experiments with extraction of indigo from dyer's knotweed. She gives courses in cultivation, commercial use and dyeing with natural dyestuffs and carries out experiments using traditional dyeing methods.

Regina Hofmann-de Keijzer studied biology at the University of Vienna. After finishing her Ph.D. study with a thesis on dye plants she did a post-doc project on Indonesian natural dyes at the Netherlands Institute for Cultural Heritage in Amsterdam. She joined the University of Applied Arts Vienna in 1996, lecturing on organic materials, biology, fibre analysis and historical dyeing techniques. Her main interest lies in the area of natural dyes and dyestuff analysis.

Experiments with Weaving and Weaving Tools
Basic considerations after 20 years of work

Ingrid Schierer

Abstract

For experimental archaeology in Austria experiments in the field of textiles – both the production of yarn and the production of fabrics – were an essential focus of research. In the museum of Asparn weaving trials were made with looms, which originally were only used as exhibits. After that the building of more looms, attempts to imitate fabrics, and genuine experiments. Now, after we have developed some understanding of weaving techniques and implements, new questions must be raised about materials and finds.

Für die experimentelle Archäologie in Österreich waren die Versuche im textilen Bereich ein wesentlicher Forschungsschwerpunkt, sowohl bezüglich der Fadenproduktion, als auch der Produktion von Geweben. Mit den im Museum zunächst nur als Ausstellungsobjekten vorhandenen Webstühlen wurden Webversuche unternommen. Es folgten der Bau weiterer Webstühle, nachahmendes Versuchen und echte Experimente. Jetzt, nachdem ein Zugang zu Webtechniken und Geräten gefunden ist, müssen neue Fragestellungen an Material und Befunde entwickelt werden.

At the symposium in Hallstatt/Austria[1], from the 4th to the 6th of June 2004, I presented pictures of different looms and weaves which originated mainly from the annual seminar on experimental archeology in Asparn/Lower Austria and from other places where we worked experimentally.

In Austria we started in the early 80's under the patronage and guidance of Helmut Windl. Asparn, previously known only as a museum, became a place of work and experimentation. The different huts and shelters were the ideal surrounding for experiments were to follow. Scientifically, there were only the widely known publications[2] to refer to, and some reconstructions of looms (Fig. 1-2).

Firstly it was necessary to get basic practical knowledge about the technique of weaving – and secondly it was necessary to get an overview of the existing finds of textiles as well as warp-weights. These two fields of skill and knowledge – the manual and the scientific one – have to be covered if a person intends to work on that topic.

The technique of weaving

It is only possible to approach this matter from a contemporary point of view. That means only industrial weaving and, to a very small extent, handweaving is accessible to us. Factory-made textiles are produced under completely different conditions from the ones created by prehistoric workers. The working process has to be translated to the past and the technical terms, which originally came from industrial weaving, are applied to the warp-weighted loom. It is important to develop a standardized draft (point-paper design) for the experimental weaver to enable

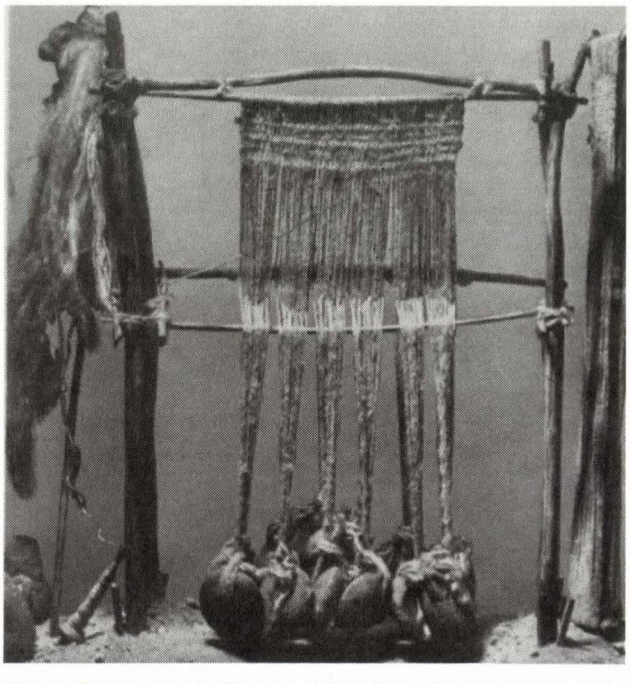

Fig. 1: Reconstructed loom, at that time shown as "Neolithic loom" in the Asparn museum (© I. Schierer).

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[1] The poster can now be seen at the Archaeological Centre near the salt-mine in Hallstatt/Hochtal.

[2] Such as: La Baume 1955. – Forbes 1964. – Hoffmann 1964. – Vogt 1937.

him or her to produce a fabric similar to the original on a reconstructed warp-weighted loom. Professional weavers, who are asked for practical advice, need a lot of explanation from the prehistorian.

The existing finds

When we started, knowledge about warp-weights was very poor. Either the unburned clay weights are lost, or they are just light clods of earth with a texture different from the surrounding material. Since the shape is lost, there is no chance to collect scientific data. The warp-weights found are sometimes spread all over a settlement, or at times found in heaps; both kinds of evidence are useless for reconstruction purposes. Warp-weights are either disk-shaped (Fig. 3) with an eccentric hole, or they are cone-shaped (Fig. 4) with the hole in the upper third. They have not changed their shape significally through the ages. Therefore, they have not been objects of great interest to the archaeologists: there are far too many of them and they are of little use in the dating of finds. They were used for was already decoded in the 19th century[3]. Undisturbed layers of warp-weights are not common[4].

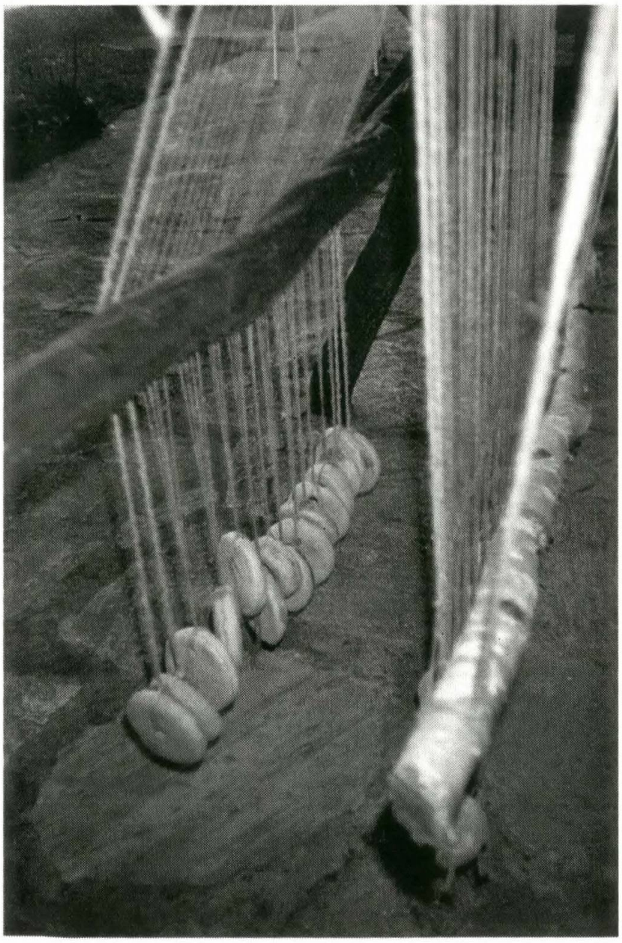

Fig. 3: Disk-shaped clay weights (© I. Schierer)

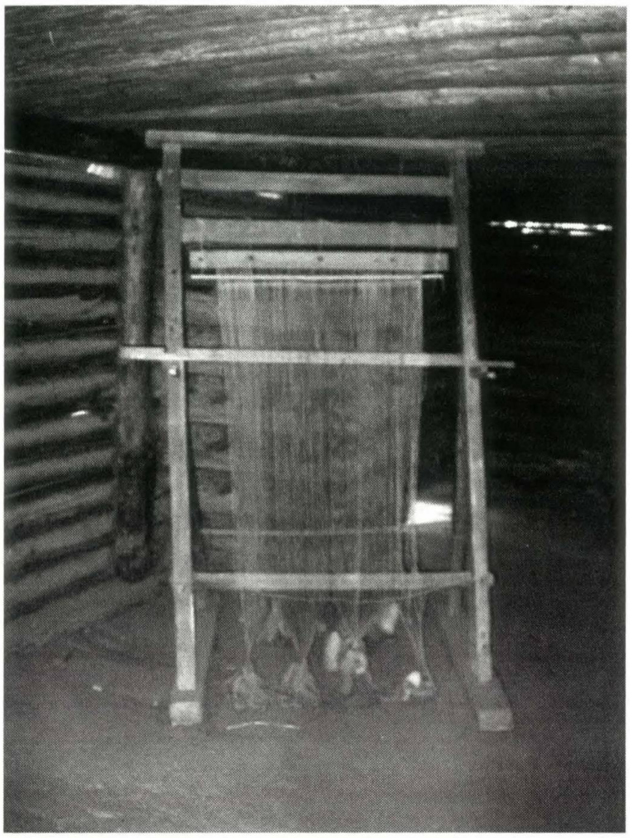

Fig. 2: Big warp-weighted loom, then shown in the so-called La-Tène-house, Asparn museum (© I. Schierer).

The surviving textiles

More often than not we have to deal with smaller samples of material, rather than larger ones. Most of them are buried in underground storage areas. The only places where they are preserved are those where the conservation conditions are suitable for textiles, as e. g. in salt-mines[5]. With the exception of a few pieces, there are no complete garments[6].

One can approach the topic from two different points of view: one using the surviving fabrics – without any hints as to the tools used, and the other examining the excavation site – without reference to the textiles produced. In the first case, only the method of imitation[7] is possible. It is appropriate to gain insights pragmatically by trying and watching, which at times lacks scientific evidence. Trying and imitating depends strongly upon the personal skill of the weaver and only proves that he or she can do it. In the second case, the scientific experiment needs clearly defi-

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[3] Keller 1861.

[4] There are only a few as impressive as Zimmermann 1982; and as Dobiat 1990: Abb. 5 and Abb. 25, pp. 83.

[5] Hundt 1959.

[6] See the finds shown by Margrethe Hald 1962 and Kurt Schlabow 1962.

[7] Ascher 1961.

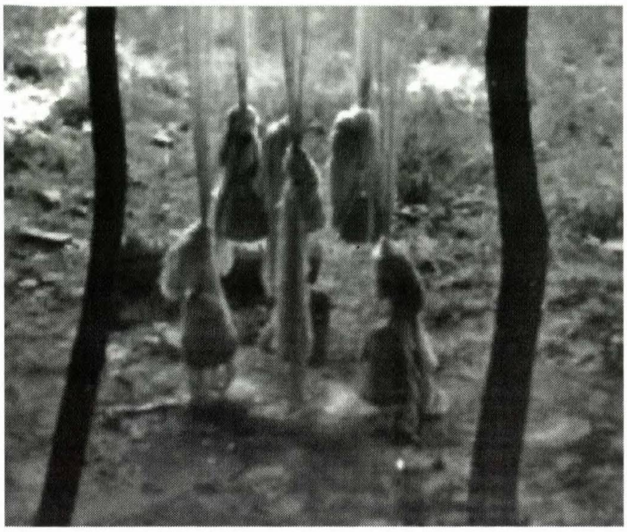

Fig. 4: Cone-shaped loom weights (© I. Schierer).

ned repetitive conditions which verify or refute the working assumptions.

The often very fine quality of prehistoric fabric is amazing. The plain, often misshapen, warp-weights mislead us into disregard them. There are no remains of the wooden frames which we could study. What we want to examine are the living conditions of prehistoric man, in order to convey the results to the interested layman.

Textile remains show a great variety in pattern, colour and weave structure. Bindings, thickness and density of the weave also show a great range. Prehistoric technology, however, limits the possibilities of weaving to tabby and twill bindings. Also the two materials linen and wool present a certain limitation. There are patterns which do not exist today, e.g. patterns with threads spun in different directions or a change of pattern within one artefact.

There are a lot of possibilities of working by imitation (Plate 18), e.g. imitation of starting borders, attempts to achieve the fineness of yarn, attempts to achieve the actual density of the fabric found, and reproduction of weaving flaws. Reproducing weaving patterns requires a lot of time and material.

For scientific experiments certain questions have to be asked:

* Did a loom originally stand at the place where the weights were found?
* Is it possible to deduce the weave from the position of the weights?
* How was the loom destroyed?
* How does one try to find out the optimal weight in relation to the thread?

The reason why we experiment with prehistoric weaving is that we want to emphasize the important role that it played in the life of prehistoric man. This fact was not seen as significant for a long time. Dealing with textiles adds to our knowledge of prehistoric cultures, especially the amount of time spent on weaving compared to other necessities. Our research covers the production of authentic textiles for exhibitions and events, as well as the process of decision making with regards to other handicrafts. Making a clear distinction between local and imported production is not always possible. The examination of textiles as a small part of cultural development yields a picture of the whole.

Experimental archaeology has two aspects. One is retrospective, i.e. it researches the methods of prehistoric production. The other is directed towards the future, presenting the results to the interested public, thus illustrating the daily life of prehistoric man.

Conclusion

In the early 80's attempts at reconstructing prehistoric weaving were mere imitations of already existing reconstructions[8]. All weaving "experiments" were conducted to gain more expertise. The main tasks for the experimental archaeologist now are to develop new questions as to the material and to opt either for scientific experiment or for the imitative approach. Materials are products of complex technical processes. Reconstructing a prehistoric loom from a piece of fabric is as difficult as it would be to build a comtemporary loom from having only the remnants of a pair of jeans. It is not so important to create true replicas of the finds, but to get an overview of the various aspects and the determining factors of the whole area of study. We also have to bear in mind that there were certainly weaving tools which have left no remains at all (Fig. 5).

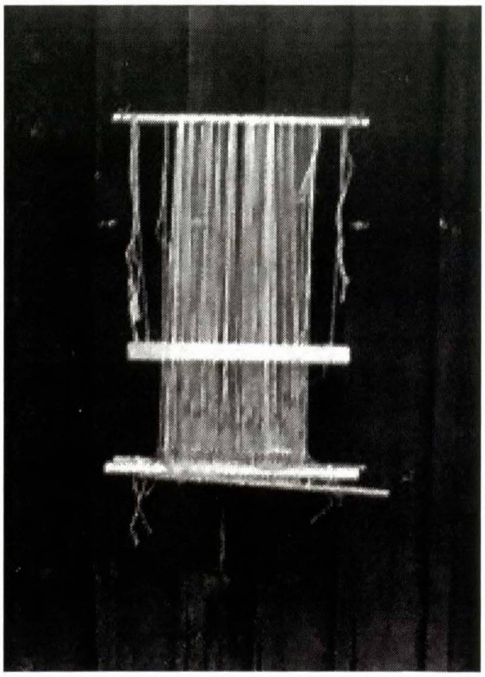

Fig. 5: Weaving implement without weights. It has to be fixed to the waist of the weaver (© I. Schierer).

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[8] Those were mainly the warp-weighted looms built by Stokar, Ullemeyer/Tidow and Stahlhofen.

Webversuche und Experimente mit Webstühlen

Ausgehend von einigen wenigen "klassischen" Publikationen und den bereits im Museum vorhandenen Rekonstruktionen von Gewichtswebstühlen gingen wir daran, einerseits praktische Erfahrung beim Weben zu sammeln und anderseits Textilfunde und Webgewichtsfunde aufzuarbeiten.

An Bereichen mussten überschaut werden: der handwerkliche Aspekt des Webens, die bekannten Befunde und die erhaltenen Textilreste. Alle Rekonstruktionsversuche waren zunächst nur ein Nachahmen bereits existierender Rekonstruktionen; alle Webversuche dienten dazu, Erfahrung zu sammeln. Mit der praktischen Erfahrung und dem theoretischen Hintergrund ausgestattet, ist jeweils neu zu entscheiden, ob nachahmend oder im wissenschaftlichen Sinn experimentell gearbeitet werden soll, bzw. kann. Gewebte Stoffe sind das Ergebnis von komplexen technischen Abläufen und man darf sich nicht erwarten, dass der Arbeitsvorgang einfach ist, nur weil die Werkzeuge primitiv aussehen. Es ist nicht unbedingt wichtig, genaue Nachbildungen zu schaffen; wichtiger ist durch das Arbeiten am Thema, die für die Produktion bestimmenden Faktoren zu erfassen. Der Zugang zu Webexperimenten im weiteren Sinn kann einerseits von den existierenden Textilresten aus erfolgen. Sie geben aber nur begrenzt Anhaltspunkte über die verwendeten Geräte und anderseits kann von den Ausgrabungsbefunden ausgegangen werden. Wobei zu bedenken ist, dass auch eine ungestörte Webgewichtslage im Normalfall keine genauen Angaben über die produzierten Gewebe zulässt. Das echte Experiment mit einer klar abgegrenzten Aufgabenstellung und der Möglichkeit zur Wiederholung ist zu unterscheiden vom nachahmenden Versuchen.

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Experiments with the warp-weighted loom of Gars-Thunau, Austria

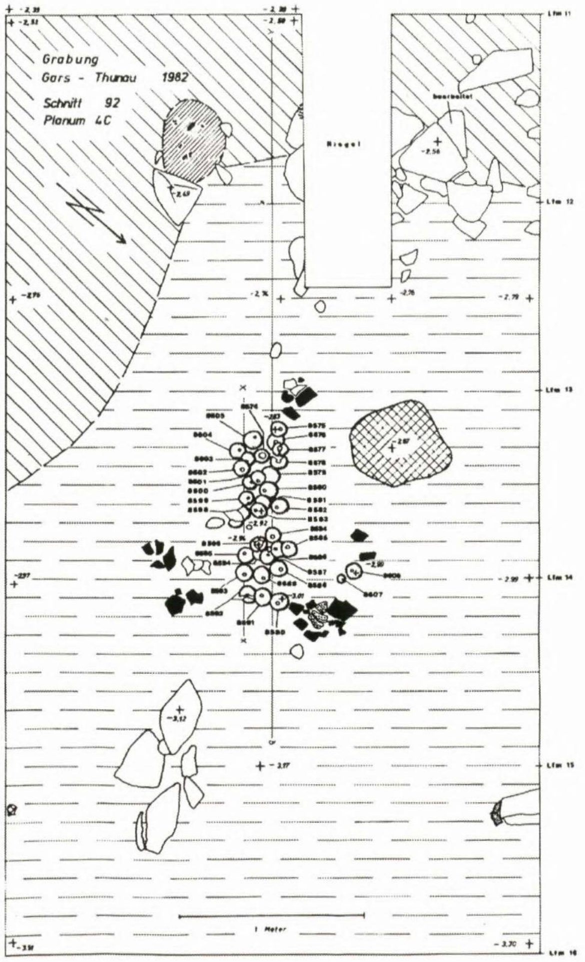
Ingrid Schierer

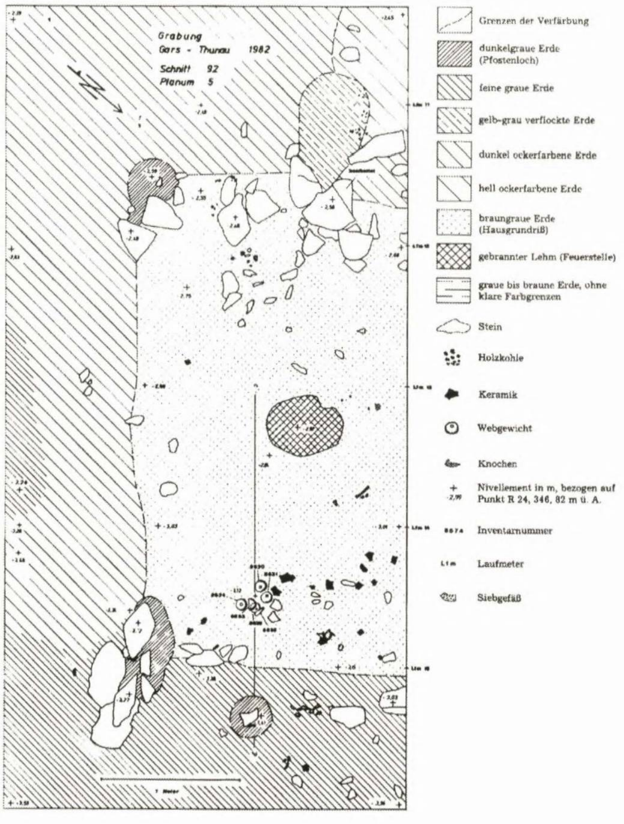
Abstract

Based on my work published in 1987 I present my experiments with the warp-weights found in Gars/Thunau. First it was neccessary to copy the weights and then I built a wooden implement corresponding with the facts of the excavation. The task was to record in which pattern the weights fall down after destroying the loom. The results of the experiments can be discussed new.

Basierend auf der bereits in der Zeitschrift Archäologia Austriaca 1987 publizierten Arbeit, werden hier meine Versuche mit der Webgewichtslage aus der Grabung in Gars/Thunau vorgestellt. Zunächst mussten Duplikate der Webgewichte hergestellt werden und dann wurde über der Zeichnung des Befundes ein Webgerät errichtet. Es galt zu beobachten, wie bei den verschiedenen Zerstörungsversuchen die Gewichte zu Boden fallen. Diese, neuerlich in Bild und Zeichnung dokumentierten "Befunde", können nun unter neuen Aspekten interpretiert werden.

I was asked to present my research on the warp-weights from Gars-Thunau/Lower Austria[1] again. This paper is based upon my work, which was published in 1987 and I am pleased to be allowed to repeat some basic facts. During the excavation in Gars-Thunau in 1982 thirty-six warp-weights were found. There was a layer of thirty-one


Grabung
Gars - Thunau 1982
Schnitt 92
Planum 4C
1 Meter


Grabung
Gars - Thunau 1982
Schnitt 92
Planum 5
Grenzen der Verfärbung
dunkelgraue Erde (Pfostenloch)
feine graue Erde
gelb-grau verflockte Erde
dunkel ockerfarbene Erde
hell ockerfarbene Erde
braungraue Erde (Hausgrundriß)
gebrannter Lehm (Feuerstelle)
graue bis braune Erde, ohne klare Farbgrenzen
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Holzkohle
Keramik
Webgewicht
Knochen
Nivellement in m, bezogen auf Punkt R 24, 346, 82 m ü. A.
Inventarnummer
Laufmeter
Siebgefäß
1 Meter

Fig. 1: Gars-Thunau (left): Planum 4C, 31 warp-weights in situ (© I. Schierer).

Fig. 2: Gars-Thunau (right): Planum 5, Note the postholes of the hut and the fireplace (© I. Schierer).

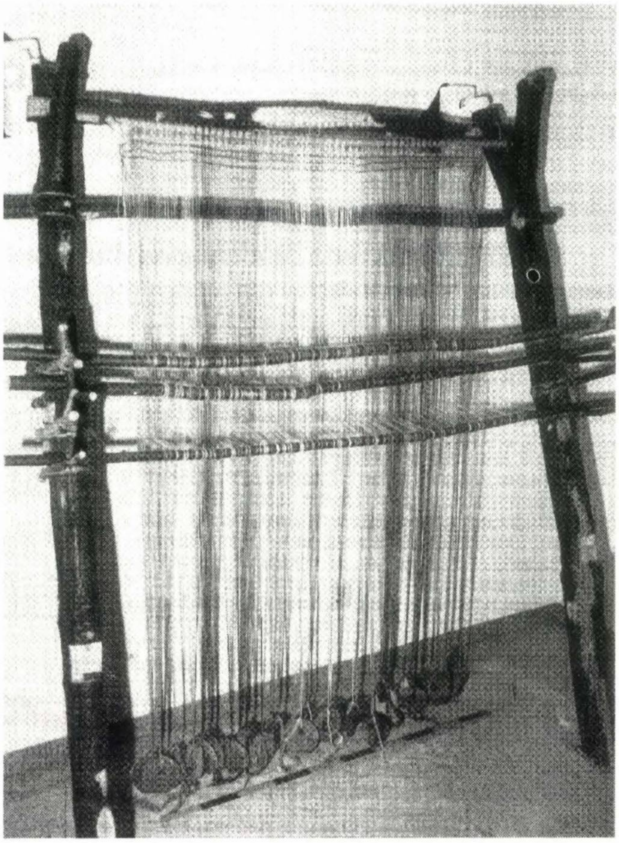

Fig. 5: Gars-Thunau-loom: Photo of the loom, used for the experiments (© I. Schierer).

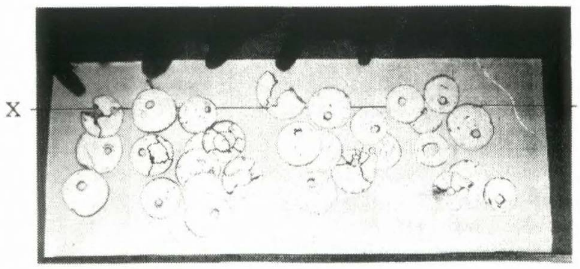

Fig. 3: Gars-Thunau-loom: Drawing of the warp-weights, arranged as they were found (© I. Schierer).

weights in situ at planum 4C (Fig. 1) and another undisturbed layer of five weights 10 cm deeper at planum 5 (Fig. 2). With the help of other finds, especially the sieve-vessel, which was found nearby, it could be dated to the Bronze Age (Hallstatt B).

The disc-shaped weights with an eccentric hole were 6.4 cm to 10.8 cm in diameter, most of them between 8.5-9.8 cm. The layer consisting of the 31 weights (Fig. 3) was approximately 1 m long and this evidence was used for the experiments – the five other weights were admitted because of their distance to the others. A dark brown coloured area parallel to the layer of weights was also noticeable; but there were no signs of postholes connected with the weights.

The loom (Fig. 4-6) used for the experiments was by no means a reconstruction, but only a wooden implement, built as simple as possible following some basic clues: the

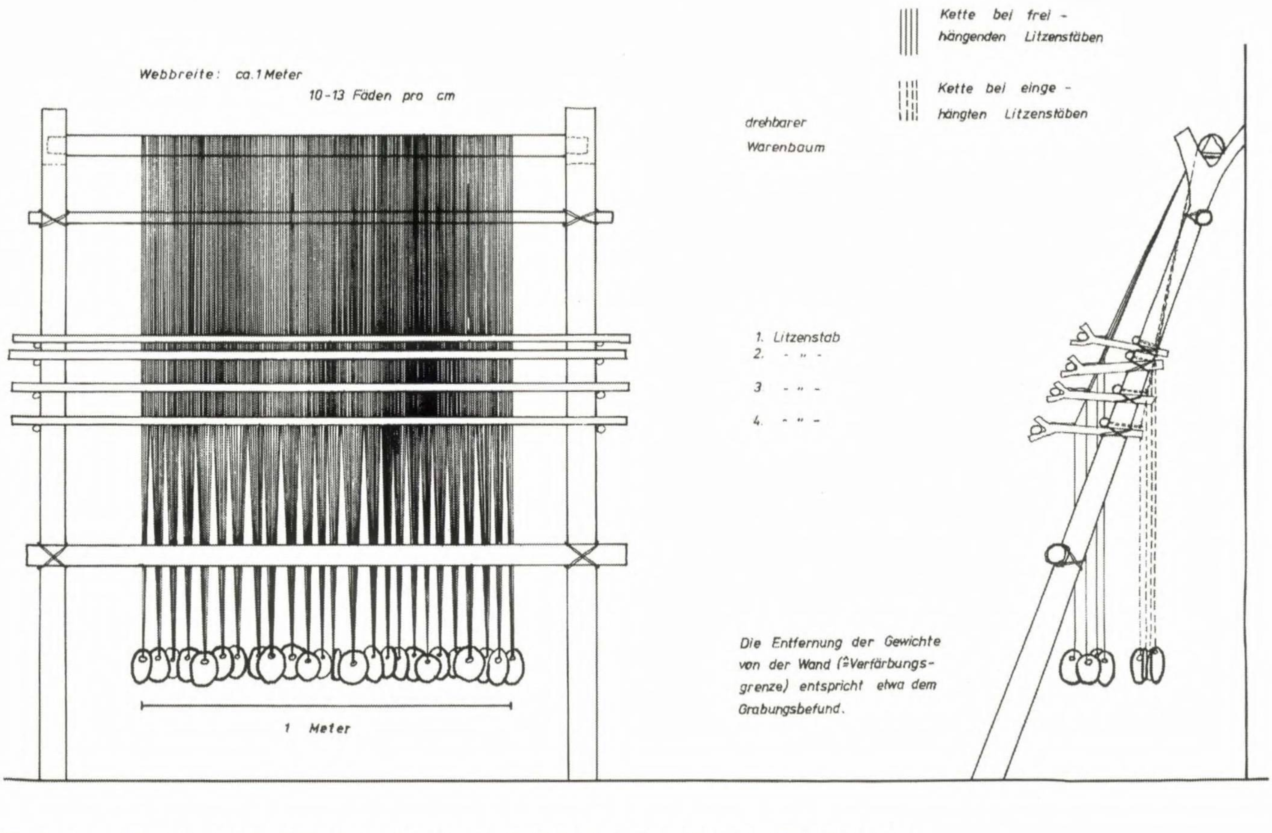
Webbreite: ca. 1 Meter
10-13 Fäden pro cm
1 Meter
drehbarer Warenbaum
Kette bei frei-hängenden Litzenstäben
Kette bei einge-hängten Litzenstäben
1. Litzenstab
2. - " -
3. - " -
4. - " -
Die Entfernung der Gewichte von der Wand (≙Verfärbungsgrenze) entspricht etwa dem Grabungsbefund.

Fig. 4: Gars-Thunau-loom: Drawing of the loom, built for the experiments (© I. Schierer).

width of the layer of weights, the line between the differently coloured areas parallel to the warp weights, ethnological examples, paintings on Greek vases and already existing reconstructions of other authors. It was possible to weave tabby or twill.

The aim of the various experiments was to find out:

- * If at this place, where the weights were found, a loom originally stood
- * If the weave could be discovered from the position of the weights
- * How the loom was destroyed

In order to verify or to disprove my assumptions, I tried to "destroy" the loom and/or the fabric, by burning the threads, or cutting them short with a knife and with scissors. For another experiment I pushed the loom sidewards until it fell over, I turned it over, and so on. The arrangement and the method of destruction may not copy exactly the original condition, but the results allow some statements to be made. Unwinding the cloth, so that the weights touch the ground, does not reproduce the slow process of natural decomposition because weight and threads stay connected (Fig. 7). Loosening the knots is an arbitrary act, usually if the piece of work is finished – heaps of weights without a significant line may be the result. My way of burning the threads was probably too gentle; it could not simulate a damaging fire from outside the hut. Using scissors or using a knife does not make a great difference. Rolling up the cloth and the remaining warp around the upper beam and laying this bundle down was also tested (Fig. 8).

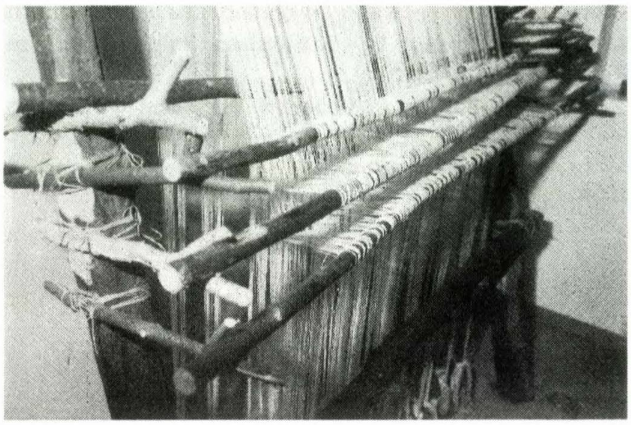

Fig. 6: Gars-Thunau-loom: Detailed view of the shafts, the heddles, the shed rod (© I. Schierer).

In the light of the experiments (Fig. 9-10) I dare say that it is very likely that a loom stood at the spot, that it was being worked on and it was in use. It is highly probable that it was threaded for twill. Tabby, with natural shed, shows a completely different pattern (Fig. 11A) and can be excluded; the pattern, shown after destroying tabby, with countershed, is questionable (Fig. 11B). Only if the loom is destroyed at one stroke, in a heavy or sudden blow – as it is in the case of fire – do the weights lie in a position comparable to the one in which was found. Contemporary (Bronze Age) textile finds[2] show that twill was known at that time, though not common. The most significant variables in the experiments result from different kinds of thread-up

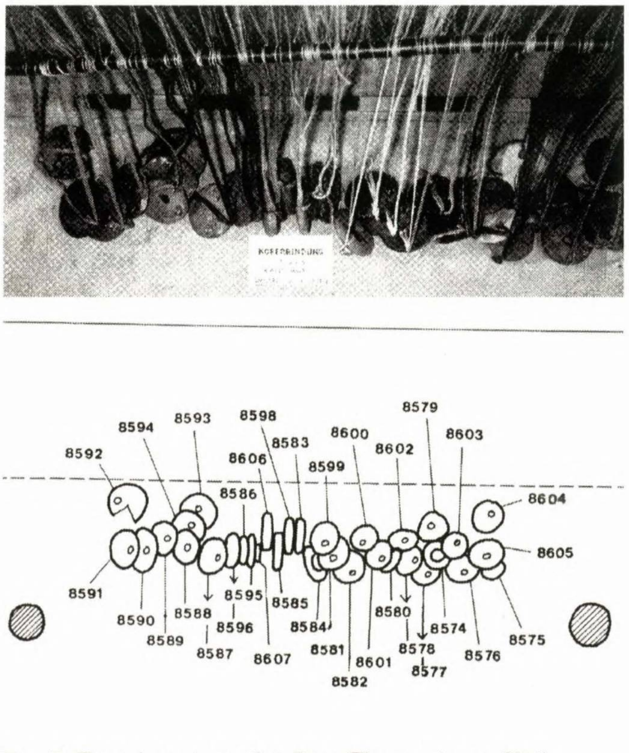
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Fig. 7: Experiments on the Gars-Thunau-loom:Cloth unwinded, please note the "standing" weights (© I. Schierer).

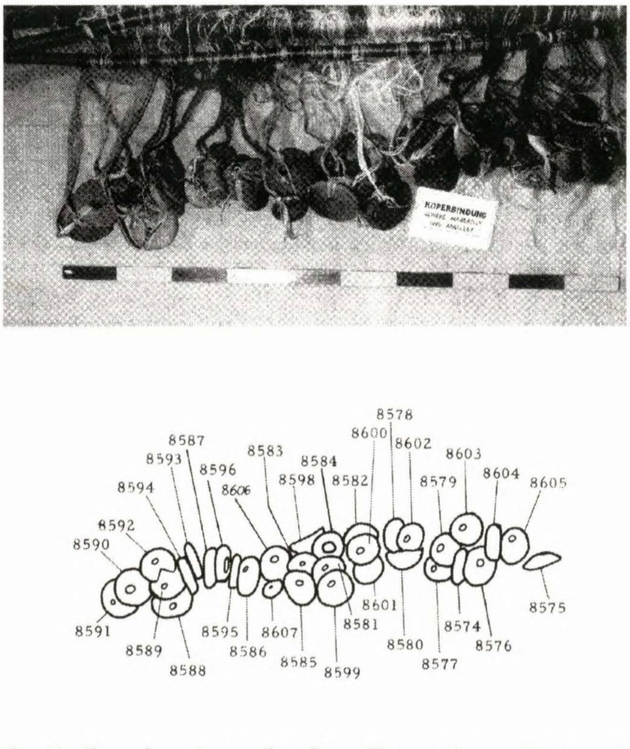
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Fig. 8: Experiments on the Gars-Thunau-loom: Transportable bundle, produces a pattern similar to the results of destruction (© I. Schierer).

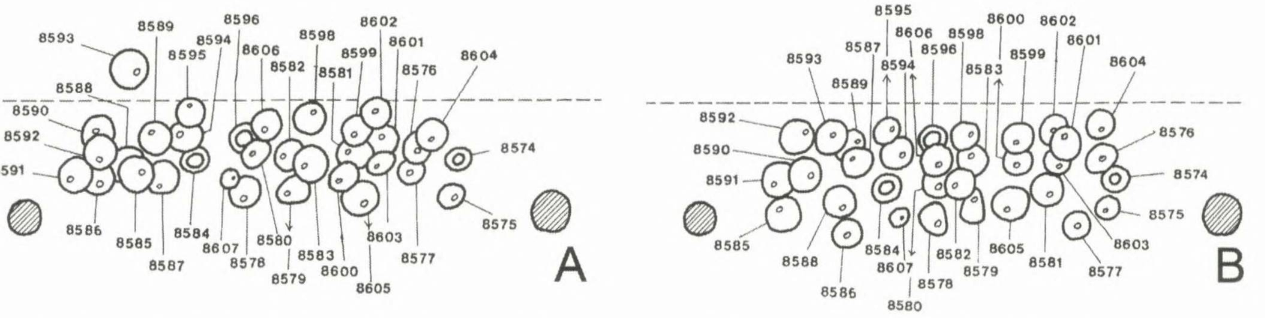

Fig. 9: Experiments on the Gars-Thunau-loom: Twill: A: Shed (1) 2-3 (4), threads burnt. – B: Shed (1) 2-3 (4), threads cut. Please compare the examples given with Fig. 3 (© I. Schierer).

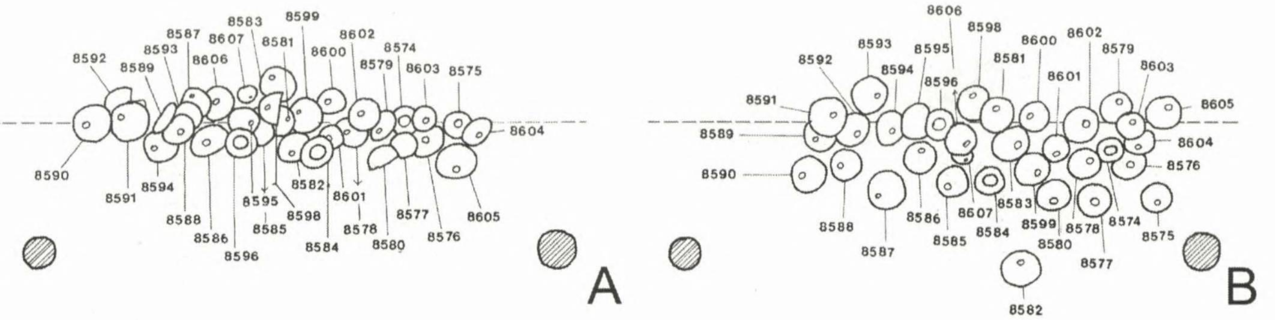

Fig. 10: Experiments on the Gars-Thunau-loom: A: Shed (1-2-3), threads burnt. – B: Shed (1-2) 3, threads cut with scissors. Please compare the examples given with Fig. 3 (© I. Schierer).

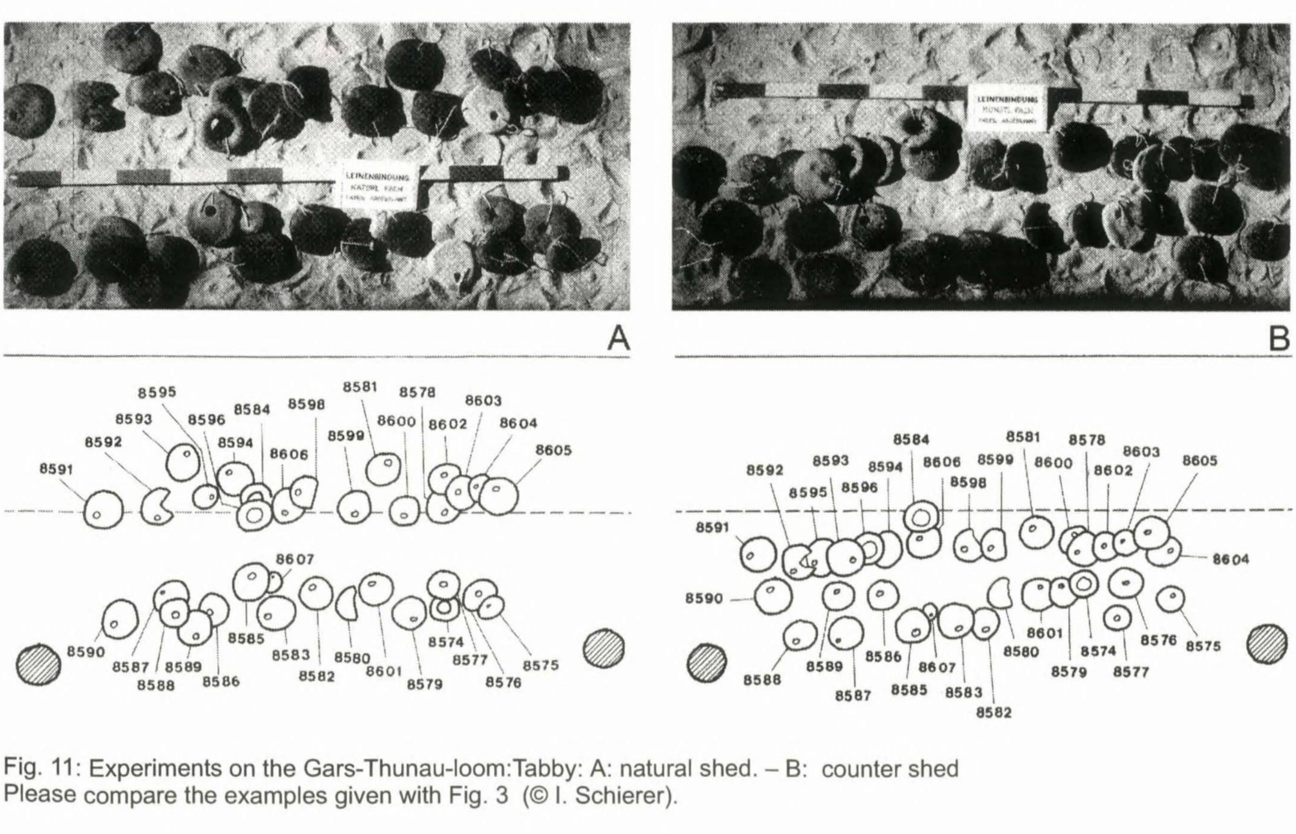

Fig. 11: Experiments on the Gars-Thunau-loom:Tabby: A: natural shed. – B: counter shed
Please compare the examples given with Fig. 3 (© I. Schierer).

(tabby or twill) and the presence or absence of natural sheds.

Ein Webstuhlbefund aus Gars-Thunau, Österreich

Rekonstruktionsversuch und Funktionsanalyse

Ausgehend vom Fund einer geschlossenen Webgewichtslage im Bereich der urnenfelderzeitlichen Siedlungsfläche wurde versucht, einen Webstuhl über den 31(+2), sich in ungestörter Lage befindlichen Webstuhlgewichten zu rekonstruieren. Anhaltspunkte dazu waren einerseits die Gewichte, anderseits die im Abstand von 40 cm parallel dazu verlaufende Verfärbungsgrenze[3], Pfostenlöcher waren keine sichtbar.

Im Experiment konnte gezeigt werden, dass höchstwahrscheinlich an der Stelle, an der die Webgewichte gefunden worden waren, ein Webstuhl mit aufgespannter Webe stand. Die Zerstörungsversuche sollten unter anderem auch die Frage klären, ob anhand der befundeten Gewichte auch die verwendete Bindungsart erschlossenen werden kann.

Die Dokumentation zahlreicher Zerstörungsversuche (über 40) zeigte, dass der Garser Webstuhl höchstwahrscheinlich in Köperbindung aufgespannt war. Die Frage nach der Art der Köperbindung muss offen bleiben. Eine Betrachtung zeitgleicher Funde, wie eben auch die Gewebereste aus dem Hallstätter Salzberg, aus dem Hohmichele und dem Dürrnberg bei Hallein legen einen (4schäftigen?) 2/2 Köper nahe.

Als Zerstörungsart könnte ein Brand in Frage kommen.

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Curriculum vitae

Ingrid Schierer has been working in the textile field since 1982, mainly in the Museum of Prehistoric History in Asparn/Zaya/NÖ. She finished her studies of History in 1997. Thesis: "*Studies about clothing in the Late Antiquity and the Early Middle Ages.*" She has presented weaving at various events.

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[1] Schierer 1987.

[2] Such as: Hundt 1971. – Hundt 1962: 199 f. –- Hundt 1959: 71. – Hell 1926: 336 f. – Jockenhövel 1974: 48.

[3] Erst in Planum 5 sichtbar

Efficiency and technique – Experiments with original spindle whorls

Karina Grömer

Abstract

In order to be able to understand better the general context of textile production in European prehistory, it is necessary to get to grips with spindle whorls – the commonest textile-related artefacts found on archaeological sites. Tests were made to establish the efficiency of various spindle whorl forms from all horizons of prehistory (Neolithic to Iron Age); measurements were taken of spindle whorl twist frequency and twist duration, together with the yarn strength achieved with the spindles. This all offers a new perspective on the rare finds of textile remains.

Um den Gesamtkontext der textilen Produktion in der Urgeschichte besser verstehen zu können, ist es nötig, sich vor allem auch mit den im archäologischen Fundgut am häufigsten vorkommenden Artefakten, den Spinnwirteln, auseinanderzusetzen. Dabei wird die Leistungsfähigkeit verschiedener Spinnwirtelformen aus allen Abschnitten der Prähistorie in Form von Messungen zur Drehfrequenz und Drehdauer eruiert, sowie auch die mit den einzelnen Spindeln erzielbaren Fadenstärken, was wiederum einen ergänzenden Blickwinkel auf die eher spärlich gefundenen Textilreste gibt.

Introduction

Textile techniques are a field hard to explore since all organic material usually decays: the tools used to produce textiles not the textiles themselves are preserved. Generally, in Central Europe we just have artefacts of stone, antler, bone or pottery. In the course of our textile research we deal with basic technique, the questions concerning spinning, the production of threads by the use of a hand-operated spindle.

The aim of this research was to assess the mechanism of prehistoric spindles, of which we only find the whorls (usually made of clay) on conventional prehistoric sites in Central Europe. It was important to evaluate the characteristics and technical facts of different spindle whorls to make statements about the mode of operation. It was tried to obtain basic data on the question of efficiency and the technique of prehistoric spindle whorls. For that it was very important to test the original artefacts (only examples in adequate condition could be used).

The experiments were carried out with whorls originating from sites in Upper and Lower Austria, dating from the Neolithic to the Roman Period (about 3.500 BC to 400 AD). The whorls were selected according to weight and shape, but above all used only items which would survive the handling undamaged. Even minor damage could affect the behaviour of a piece; for its weight or shape might change more or less, which could influence the turning properties.

Within this experiments the typical big whorls from the late Neolithic Jevišovice Culture from Meidling/Kleiner Anzingerberg and Krems-Hundsteig were tested. From the Early Iron Age we have very small, variously shaped and richly decorated whorls; for the experiments we used examples from Malleiten/Bad Fischau (Early Iron Age, HaC) and Hallstatt (Early Iron Age, HaC and HaD). The originals from a later period, from Mannersdorf (Late Iron Age, LtB) and Halbturn (Late Roman Period, 2.-5. cent. AD)[1], which were tested, were similar (Fig. 1).

Different techniques of spinning

In prehistoric times the hand-operated spindle consisted of a wooden stick and a whorl as flywheel, usually made of clay[2].

In the process of spinning the fibres were twisted to achieve a thread of a specific thickness. The spindle has to be rotated, the woollen or flax fibres were drafted and immediately twisted to a thread. It is possible to hold a pick of fleece in one hand and to spin the thread directly "out of the hand". For carrying a large quantum of wool or for spinning flax a distaff is needed, which is a long stick: The phytogenetic material or extended fibres have to be fixed

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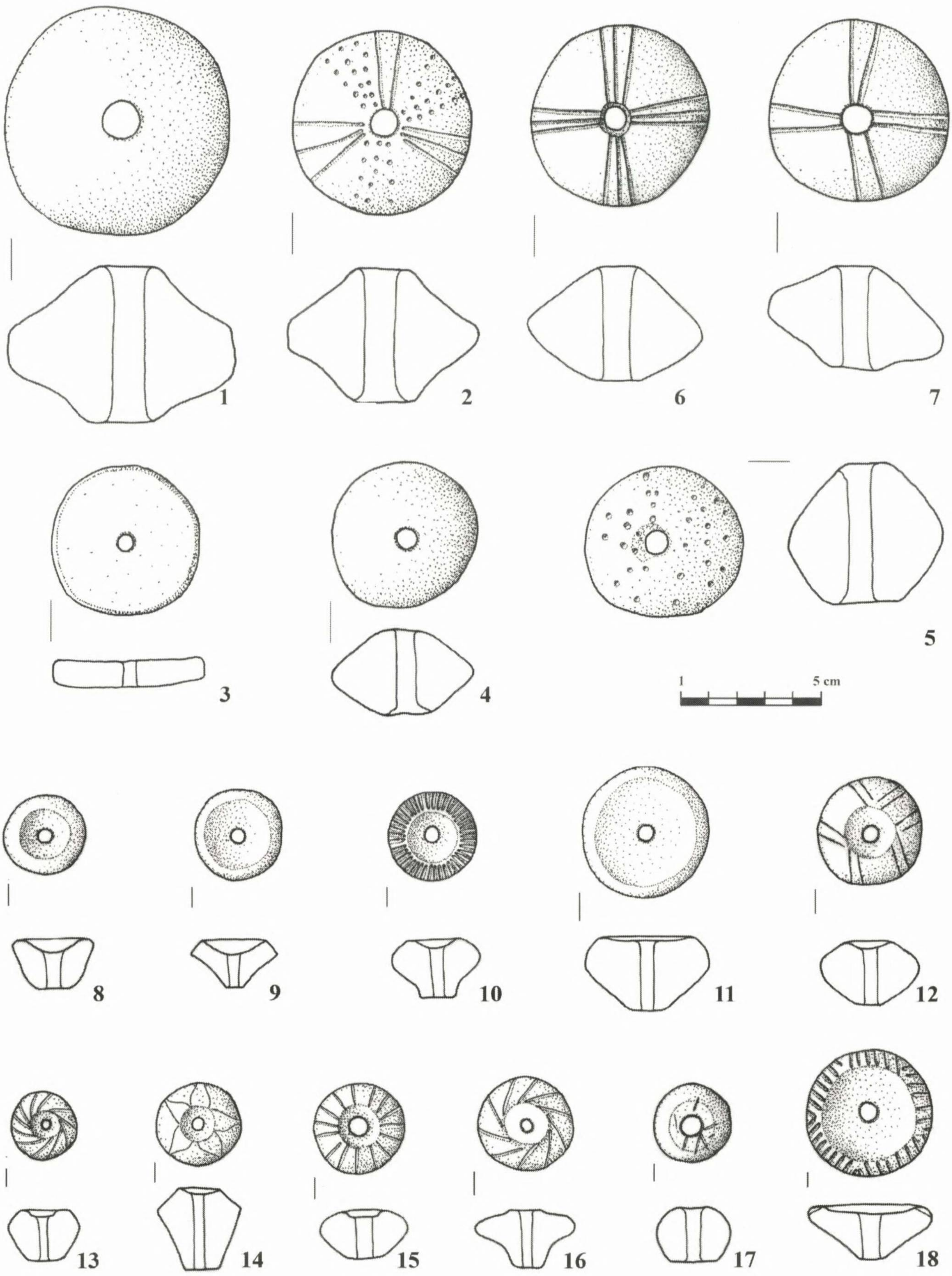
[1] Thanks for making the original whorls available to: Institute for Prehistory, Vienna (Malleiten), Dr. Alexandra Krenn-Leeb (Meidling), ASINOE (Krems/Hundsteig), Museum of Natural History (Hallstatt), Peter Ramsl (Mannersdorf), Nives Doneus (Halbturn)

[2] More detailed see Grömer 2003.


1
2
6
7
3
4
5
5 cm
8
9
10
11
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13
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17
18

Fig. 1: Prehistoric spindle whorls used for the experiments: 1-5: Krems/Hundssteig. – 6-8: Meidling/Kleiner Anzingerberg. – 9-12: Malleiten/Bad Fischau. – 13-16: Hallstatt. – 17: Mannersdorf a. Leithagebirge. – 18: Halbturn (The numbers correspond with Fig. 7) (© K. Grömer).

on and worked with both hands. If the thread is long enough, it can be wound around the spindle- stick before continuing to spin.

There are two different basic techniques (with a lot of variations of each) applied to spin threads with a hand-operated spindle. The first is the use of the spindle „free hanging“ on the lenghtening thread (Fig. 2); the second is to let the spindle run on the ground or in a vessel (Fig. 3).

The advantage of the second technique is that gravity has no influence on the spinning process. But with this technique the spinner has to stay on one place, while the use of the spindle „free hanging“ makes it possible to spin while sitting, standing, walking or even while riding on muleback. In addition to producing single yarns a spindle can also be used to ply two or more threads together.

The Experiments

For all experiments the original whorls were attached to standarised wooden sticks of 27-29 cm length, with a weight of 3-5 g. For the smaller whorls thinner rods of 3 g, for the bigger ones sticks of 5 g were used (Fig. 4).

It has to be mentioned that the results of all experiments are influenced by my personal manual skills (I have about 10 years spinning experience); results achieved by another person even under similar conditions and circumstances might be different, but in general we would expect the same results.

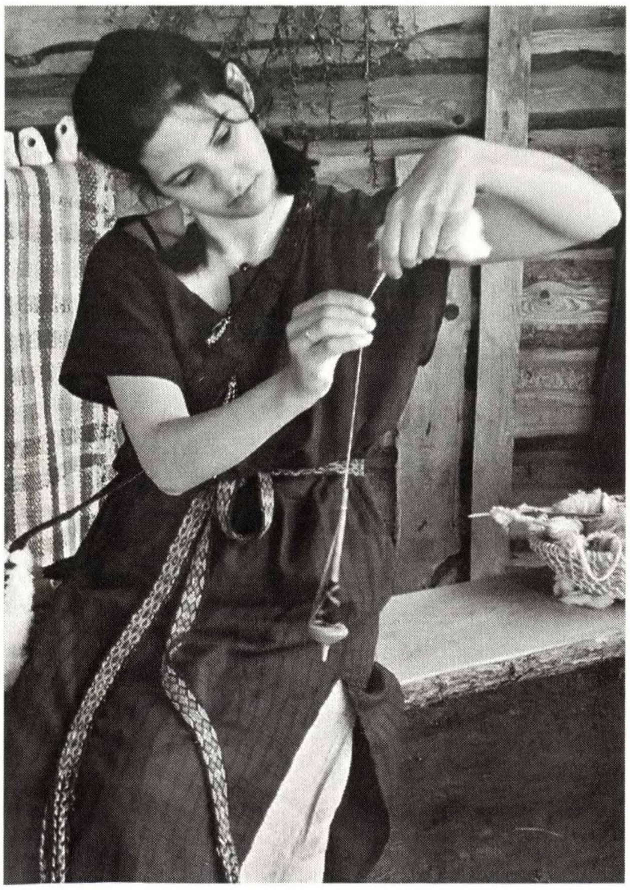

Fig. 2: Spinning with a „free hanging“ hand-operated spindle (© K. Grömer).

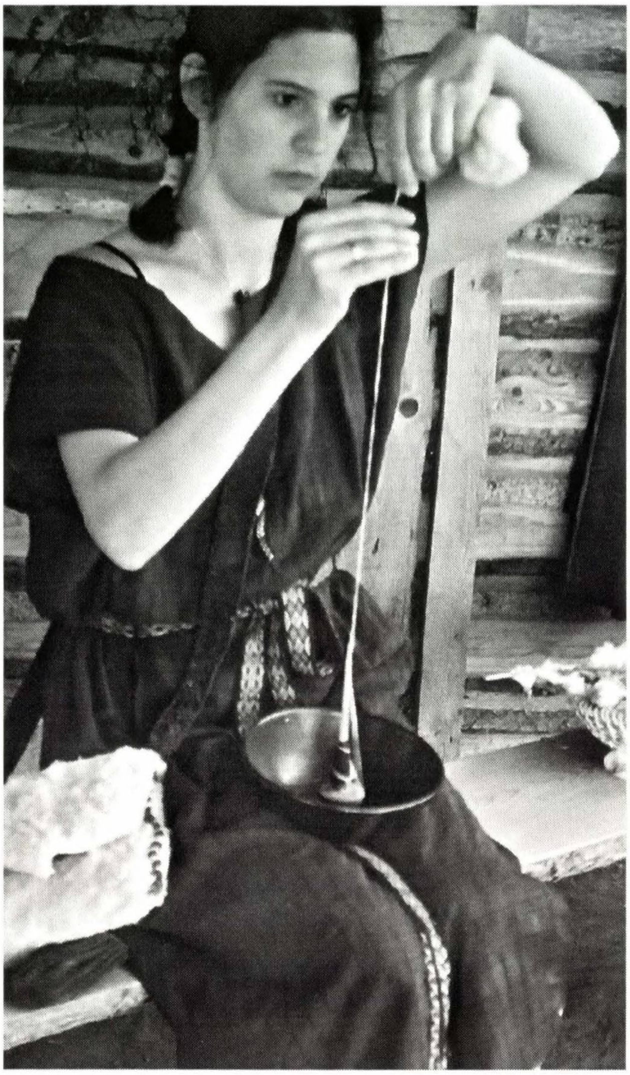

Fig. 3: Spinning with a hand-operated spindle, running in a vessel (© K. Grömer).

Relation between the weight of the whorls and the thread thickness

To examine the question of a relationship between the weight of the whorls and the thickness of the threads that can be achieved, we tested two quite different types of spindle whorls (Fig. 5). We used the original artefacts from Hallstatt (weights of the whorls between 8-20 g, Early Iron Age) and from Meidling (weights of the whorls between 120-140 g). Such extremely big whorls are typical for the late Neolithic Jevišovice Culture (in Moravia and Lower Austria) and for the Chamer Culture (in Upper Austria and Soutern Germany, around 3.000 BC). Those big whorls here are seen as artefacts for spinning, but it has to be mentioned that they are even heavy enough bo be used for weaving.

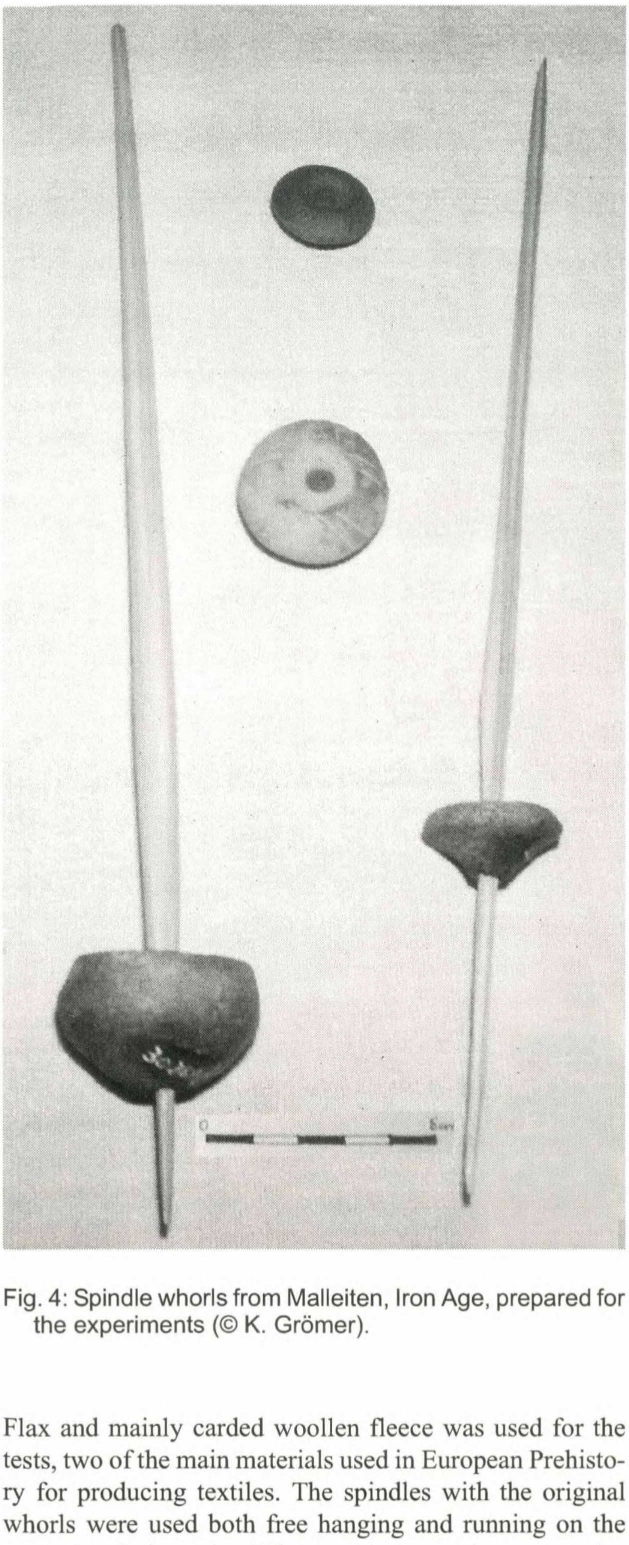

Fig. 4: Spindle whorls from Malleiten, Iron Age, prepared for the experiments (© K. Grömer).

Flax and mainly carded woollen fleece was used for the tests, two of the main materials used in European Prehistory for producing textiles. The spindles with the original whorls were used both free hanging and running on the ground to find out the differences between those two spinning techniques.

As a result of our experiments (Fig. 6) generally we can state that heavier whorls go better with thick woollen threads (for wool at between 0.7-2 mm and even more) or flax, but only if the technique of letting the spindle hang free is adopted.

When the spindle is used running on the ground (or in a bowl) fine threads of 0.3 mm diameter can also be spun with heavy whorls (more than 100 g); for gravity does not affect the spinning process or break the thread. The best results using very heavy spindles were achieved in producing threads of 0.8 to 1.5 mm. They go very well, quick and easy, without a lot of concentration (which is needed in spinning very fine yarns that they do not break). The work even can be done walking.

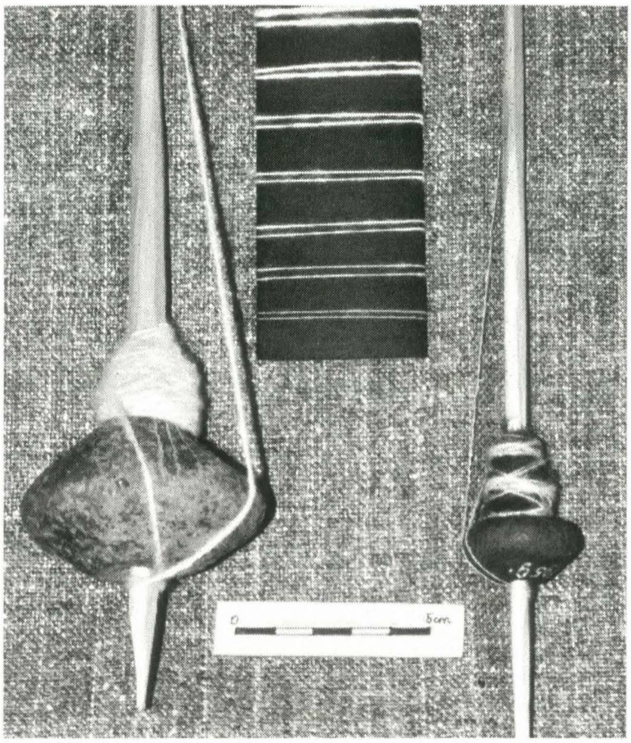

Fig. 5: Comparison between an averaged thread spun with a heavy Neolithic whorl from Meidling (133 g) and with a light Iron Age whorl from Hallstatt (12 g) (© K. Grömer).

A very light spindle with a weight of 10-20 g cannot be used for threads at more than 1.5 mm diameter or flax, what ever technique is employed. Because the thread is so thick, the spindle quickly stops and tries to turn backwards, so the thread cannot be twisted correctly. By running in a bowl the whorl is additionally slowes down, which has a negative effect on the efficiency. By means, trying hard it is possible to spin thick woollen threads or flax with very light spindles, but that was surely not the intended function of this tool. With a small spindle not enough inertial power can be produced to spin thick or stiff fibres. The best results we achieved were with woollen threads between 0.2 and 0.7 mm thick. It is no problem to produce very thin threads of 0.2 mm thickness, such as can be found at the prehistoric salt-mines at Hallstatt.

A common result of the testing of the two different types of spindle whorls (Fig. 6) is that the often published view[3], that heavy whorls are useful for the production of thick woollen threads and flax, and light whorls are good for spinning thin woollen threads can be verified. It became

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[3] For example see Rast-Eicher 1997: 304. – Dunning 1992: 43 f. – Schade-Lindig and Schmitt 2003: 12 f.

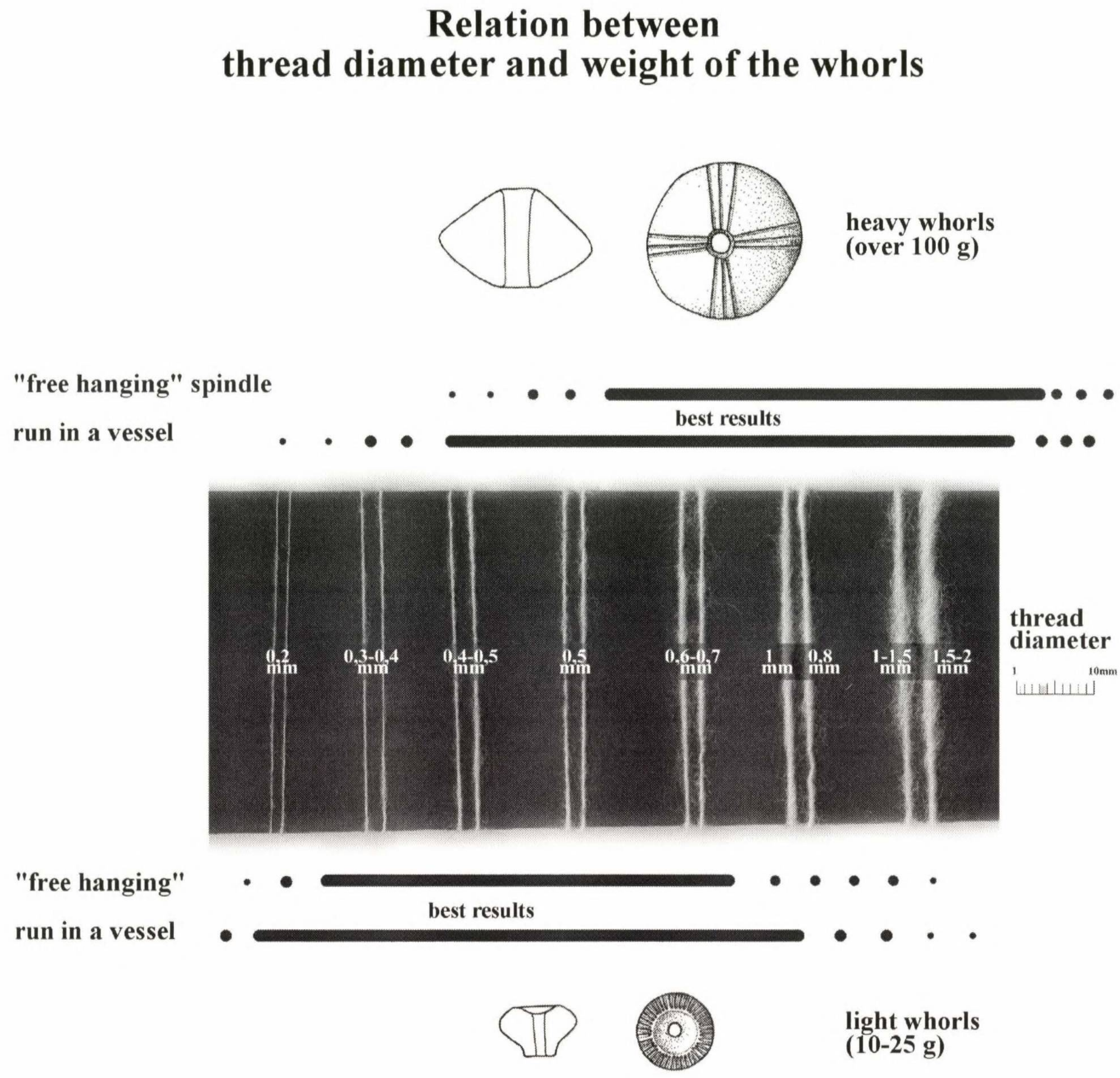
Relation between
thread diameter and weight of the whorls
heavy whorls
(over 100 g)
"free hanging" spindle
run in a vessel
best results
0,2 mm
0,3-0,4 mm
0,4-0,5 mm
0,5 mm
0,6-0,7 mm
1 mm
0,8 mm
1-1,5 mm
1,5-2 mm
thread diameter
1
10mm
"free hanging"
run in a vessel
best results
light whorls
(10-25 g)

Fig. 6: Relation between thread diameter and weight of the whorls. Differences between extremely light and extremely heavy whorls and differences between using the spindle free hanging or run in a vessel. The experiment was made in spinning wool (© K. Grömer).

evident that whorls between these two extremes brought results between the minimum and maximum achieved. In my experience whorls with a weight around 40 g are practical for nearly every thread thickness which was used in European prehistory.

Comparing the thread thickness of yarns found at Late Neolithic and Hallstatt Period sites, these results fit very well with archaeological finds. For the Hallstatt Period very small whorls with 10-15 g weight are very often; the biggest are about 40 g. Even the woven farbics of that age frequently show fine yarns of 0.2-0.5 mm thickness. Ones thicker than 1 mm are rarely evidenced[4]. The rare yarns from Neolithic sites (most of them from lake dwellings in Switzerland) are usually around 0.6-1.2 mm and of plant fibre. The Swiss Neolithic whorls are usually heavier than the Hallstatt Age ones, about 20-100 g[5].

Frequency of turns and time-measurement of operation

The aim of the experiments was to find out differences in the efficiency of spindle whorls from the Neolithic to the Iron Age and Late Roman Period. The differences are evi-

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[4] See Grömer, The Textiles from the prehistoric salt-mines in Hallstatt, in this volume.

[5] For example the late neolithic settlement Arbon-Bleiche 3: Leuzinger 2002: 119, Fig. 151 and 123, Fig. 160.

No.	Site	Date	Material	Diameter	Thickness	Weight	Frequ. 1	Frequ. 2	Time
1	**Krems**/Hundssteig, Nr. 523	Late Neolithic	darkbrown clay	7,9 cm	5,1 cm	259 g	59	73	63 sec
2	**Krems**/Hundssteig, Nr. 561	Late Neolithic	brownish clay	6,4 cm	4,8 cm	147 g	78	94	57 sec
3	**Krems**/Hundssteig, Nr.168	Late Neolithic	reddish clay	5,3 cm	0,9 cm	39,5 g	140	171	37 sec
4	**Krems**/Hundssteig, Nr. 548/1	Late Neolithic	redbrown clay	5,4 cm	3,1 cm	78 g	122	136	45 sec
5	**Krems**/Hundssteig, Nr. 548/2	Late Neolithic	darkgrey clay	5,7 cm	5,1 cm	124 g	90	109	54 sec
6	**Meidling**/Kl. Anzingerberg, FNr. 3787	Late Neolithic	darkbrown clay	6,1 cm	4,1 cm	133 g	81	105	58 sec
7	**Meidling**/Kl. Anzingerberg, FNr 842	Late Neolithic	greybrown clay	6,7 cm	3,9 cm	141 g	79	99	55 sec
8	**Meidling**/Kl. Anzingerberg, FNr 122	Neolithic?	reddish clay	3,2 cm	1,9 cm	19 g	162	209	28 sec
9	**Malleiten**/Bad Fischau, Nr. 30269/19	Ha C	hellbrown clay	3,8 cm	2,3 cm	24 g	156	200	29 sec
10	**Malleiten**/Bad Fischau, Nr. 30269/3	Ha C	greybrown clay	2,7 cm	1,3 cm	8 g	160	223	17 sec
11	**Malleiten**/Bad Fischau, Nr. 30269/43	Ha C	greybrown clay	4,5 cm	2,6 cm	42 g	145	175	38 sec
12	**Malleiten**/Bad Fischau, Nr. 30269/33	Ha C	grey clay	3,3 cm	1,7 cm	9 g	154	220	18 sec
13	**Hallstatt**, Grave 380, Nr. 24.827	Ha C	redbrown clay	2,4 cm	1,8 cm	8 g	154	225	15 sec
14	**Hallstatt**, Grave 58, Nr. 23.831	Ha C	darkbrown clay	2,8 cm	2,7 cm	14 g	150	202	18 sec
15	**Hallstatt**, Grave 87, Nr. 23.959/1	Ha D	greybrown clay	3,1 cm	1,6 cm	12 g	161	220	21 sec
16	**Hallstatt**, Grave 87, Nr. 23.959/2	Ha D	black clay	3,4 cm	2 cm	12 g	155	218	19 sec
17	**Mannersdorf** a. Leithagebirge, Gr. 95	LT B	grey clay	2,9 cm	2 cm	20 g	161	208	34 sec
18	**Halbturn**, Grave 20	2.-5. cent. AD	grey clay	4,2 cm	1,7 cm	30 g	145	185	36 sec

Fig. 7: Experiments on the frequency of turns and time of operation: Work with free hanging spindle. (time: operation time, in seconds. Frequ. 1: Frequency of turns in 6 seconds, 1 single turn. Frequ. 2: Frequency of turns in 6 seconds, repeated turns. Ha C+D: Early Iron Age, Hallstatt Period. Lt B: Late Iron Age, Latène Period). The numbers correspond with Fig. 1 (© K. Grömer)

dent from the shape and particularly the weight of the spindle whorls.

To evaluate work with a free hanging spindle of different prehistoric eras, the duration of operation (how long does the spindle turn, in seconds) and the frequency of turns (number of twists in 6 seconds) are examined[6].

It is very important for the spinning process that the spindle rotates for as long as possible after it has been set in motion; for each movement of the hand means an additional effort. With a high frequency of turns the developing thread can be very quickly twisted to get the desired number of turns.

In our experiments (Fig. 8) on the number of turns the spindles were used free hanging. Two differently coloured threads were twist together, thus making it easier to count the turns. For the turning frequence experiments the spindle was hanging free; the turns were counted in standardized intervals of 6 sec. Two different points were tested, the number of twists in a) one single turn and b) repeated turns within the 6 seconds. For every whorl of each test 5 measurements were taken and the averaged result is shown in table Fig. 7. A high frequence is positive also because the thread can be spun very fast in the desired number of turns (Fig. 8). The whorls with a weight between 124 to 147 g turned after being set in motion 78 to 90 times in 6 seconds. The lightest spindles weighing 10-20 g completed between 140 and 170 turns. Repeated motion of the light spindles within the 6 seconds shows axial rotations of 220-175 turns.

The influence of the weight on the efficiency (light whorls generally have a higher number of rotation than heavier ones) changes in the course of conventional spinning due to the weight of the spun thread wrapped around the spindle. The air resistance of the bundle of newly spun threads also works as an energy-absorber and slows down light spindles.

The shape of whorls has great effect on the spinning-process: discoid pieces turn faster than spherical ones; for their centre of gravity is further away from the axis.

Measuring the duration of turning after settinng in motion we saw that light spindles turn much for a shorter time than more massive examples. Heavy whorls weighing 124

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[6] Compare with Bohnsack 1985: 57 ff.

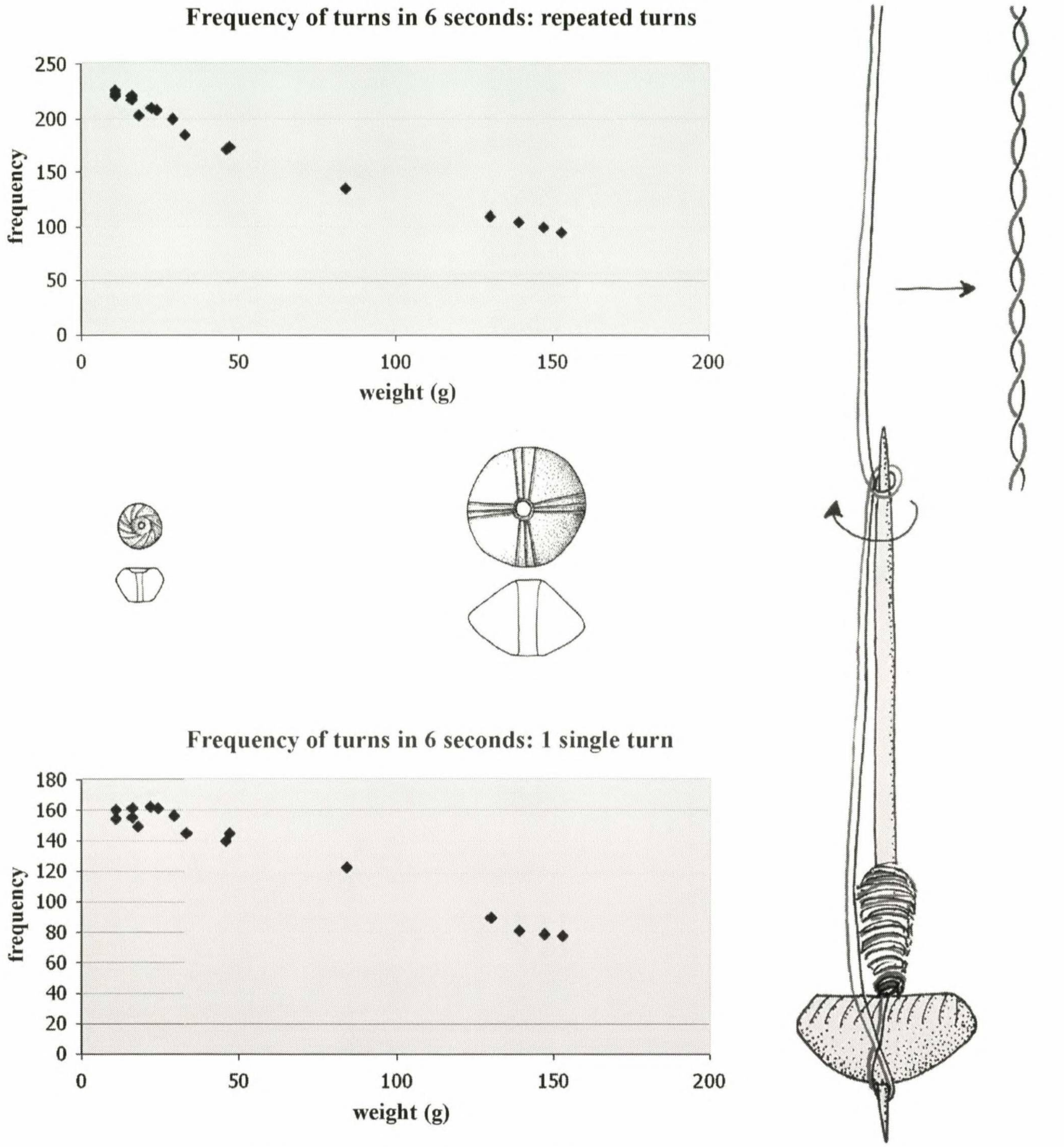

Fig. 8: Frequency of turns: Number of twists in 6 seconds, difference between repeated turns (above) and one single turn (below) within that time. Differences between light and heavy whorls (© K. Grömer).

to 147 g turned up to one minute, while light pieces of 10-15 g turned only 15-20 seconds. Each whorl was fitted with a spindle, hung on a 2 m thread and given one twist. To get an objective result, 3 tests were carried out with each spindle whorl and the results were averaged.

For the measurement of the rotating time the spindle was hung on a 2 m long thread and turned once. The aim was to find out for how long one spindle turns (in seconds) until it stops and begins to turn backwards. In this experiment three measurements were taken from each whorl and the averaged time is shown in table Fig. 7.

Results

Taken as a whole the experiments inducate that the weight of the spindle whorl and therefore its efficiency, the number of turns once the spindle has been set in motion and the rotating time have a direct influence in the purpose of the spindles (and whorls).

The great speed with which larger spindles twist the thread, together with their lesser weight, is an advantage in the production of fine wool yarns, since fine yarns (perhaps 0.2-0.4 mm thick), assuming a comperable lenght and twist angle, require many more rotations than yarn of (say) 1.5 mm diameter. The disadvantage of very light spindles, that they have to be reset in motion more often, is somewhat reduced to the great number of turns in each sequence.

For the production of very thick wool threads (over 1.5 mm) it is important that the spindle should have great mass and be very long and harmonious twining, which guarantees an even rotation sequence. It is of minor consequence that heavy whorls show a smaller number of turns; for thick yarns of a length that can be achieved in a single operation the spindle does not have to be set in motion so often to stabilise the thread.

Leistung und Technik – Experimente zum Spinnen mit Originalspinnwirtel

Der gesamte Bereich der Textilen Techniken ist im archäologischen Fundmaterial aufgrund der Vergänglichkeit organischer Materialien meist nur indirekt, in Form der für die Herstellung verwendeten Geräte erhalten. Diese bestehen oft aus Materialien wie Stein, Knochen oder Ton und konnten daher in unseren Breiten im Boden überdauern. Die hier behandelte Fragestellung bezieht sich auf das Spinnen, der Bildung von Fäden mittels Handspindel. Um die Wirkungsweise prähistorischer Spindeln – im archäologischen Fundmaterial großteils nur als tönerne Spinnwirtel fassbar – bewerten zu können, ist es nötig, sich mit den Eigenschaften verschiedener Spinnwirtel und damit den unterschiedlichen technischen Gegebenheiten auseinanderzusetzen.

Es wurde versucht, den verschiedenen Aussagen zu Leistung und Technik der Spindeln in der Urgeschichte eine Datenbasis zu geben. Um möglichst authentische Ergebnisse zu erhalten, war es unbedingt notwendig, die prähistorischen Wirteln selbst zu testen, vorausgesetzt der Zustand der Artefakte erlaubte dies. Verwendet wurden für die verschiedenen Experimente Originalspinnwirtel aus Ober- und Niederösterreich vom Neolithikum bis zur römischen Kaiserzeit (Fig. 1).

Das Spinnen in verschiedenen Techniken

In der Urgeschichte wurde mit der Handspindel gesponnen, die aus einem hölzernen Stab und einer meist tönernen, als Schwunggewicht dienenden Spinnwirtel besteht. Beim Spinnen werden einzelne Fasern miteinander zu einem beliebig dicken Faden verdrillt. Das Wollvlies, bzw. das Flachsbündel (Bast etc.) wird gleichmäßig zu einem dünnen Band verzogen, die Spindel wird in Drehung versetzt und durch diese Drehung verzwirbelt sich das Faser-

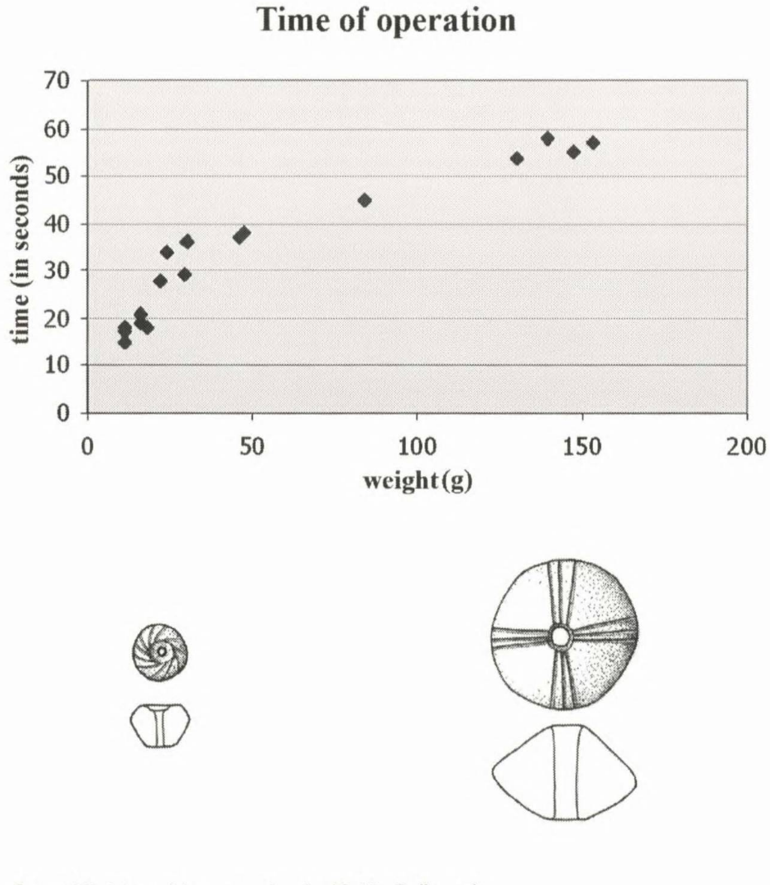

Fig. 9: Duration of operation of light and heavy whorls (© K. Grömer).

material sofort zu einem Faden. Bei Schafwolle kann das Vlies in der Hand gehalten und sozusagen „aus der Hand gesponnen" werden. Beim Verspinnen von Flachs oder anderen pflanzlichen bzw. langfaserigen Materialien muss ein Hilfsmittel, der Spinnrocken, verwendet werden, von dem mit beiden Händen die Fasern verzogen werden.

Es sind beim Spinnen mit der Handspindel zwei unterschiedliche Grundtechniken mit zahlreichen Abwandlungen möglich. Zum einen wird die Spindel „hängend" verwendet, sodass die Spindel an dem gerade entstehenden Faden in der Luft hängt (Fig. 2). Andererseits ist es auch möglich, die Spindel in einer Schale (Fig. 3) oder auch auf dem Boden laufen zu lassen, sodass die Schwerkraft nicht auf sie einwirkt. Es können mit der Spindel auch zwei oder mehrere Fäden miteinander verzwirnt werden.

Die Experimente

Spinnwirtelgewicht in Relation zur Fadenstärke

Bei der Frage, welcher Zusammenhang zwischen dem Gewicht einer Spinnwirtel und möglichen erzielbaren Fadenstärken beim Verspinnen von Wollvlies und Flachs besteht, wurden Originalspinnwirtel aus Meidling/Kleiner Anzingerberg (Spätneolithikum, mit Gewichten zwischen 120-140 g), sowie aus Hallstatt (ältere Eisenzeit, mit Gewichten von 8-20 g) getestet.

Allgemein kann als Ergebnis (Fig. 6) festgehalten werden, dass sich schwere Spinnwirtel eher für dickere Wollfäden und für Flachs eignen, wobei einschränkend hinzugefügt werden muss, dass dies nur bei der Spinntechnik gilt, bei der die Spindel frei hängend verwendet wird.

Wird die Spindel am Boden (in einer Schale) laufend verwendet, so ist mit einer schweren Spindel über 100 g auch bei Wolle eine sehr feine Fadenstärke von 0,3 mm herstellbar, da die Schwerkraft nicht auf den Faden einwirkt.

Eine sehr leichte Spindel mit ca. 10-20 g ist hingegen nicht in der Lage, zu dicke Wollfäden (ab 1,5 mm Stärke) oder Flachs zu verarbeiten, unabhängig von der Spinntechnik. Im Gegenteil, wird sie am Boden laufend verwendet, so wird sie noch zusätzlich gebremst, was die Effizienz noch mehr beeinträchtigt.

Drehfrequenz und Laufzeit

Ziel ist es, etwaige Unterschiede bei Spinnwirtel unterschiedlicher Zeitstellung festzustellen, die sich auf die Leistungsfähigkeit der Spinnwirtel auswirken. Diese Unterscheide liegen vor allem im Gewicht, aber auch in der Form der Spinnwirtel. Um die Spinnarbeit mit der frei hängenden Spindel unterschiedlicher Zeitstufen richtig einschätzen zu können, wurde die Laufzeit (Drehdauer: Zeit bis zum Stillstand der Spindel bei einmaligem Andrehen) und Frequenz der Spindel (Umdrehungszahl pro Zeiteinheit, hier 6 sec.) untersucht.

Wesentlich ist für die Produktivität beim Spinnprozess, dass sich die Spindel möglichst lange dreht, da man die Spindel dann nicht so oft andrehen muss – jeweils ein zusätzlicher Handgriff beim Spinnen. Eine sehr hohe Spinnfrequenz ist jedoch auch von Vorteil, da der entstehende Faden schnell mit den gewünschten Drehungen versehen werden kann.

Die Stücke mit einem Gewicht von 124 bis 147 g drehten sich in 6 sec. bei einmaligem Andrehen 90-78 mal (Fig. 7-8). Die leichtesten Spindeln zwischen 10-20 g konnten vergleichsweise mit einer doppelten Drehfrequenz von 140-170 Umdrehungen aufwarten. Dieser Einfluss des Gewichtes auf die Leistungsfähigkeit (die leichteren Spindeln haben eine höhere Drehfrequenz als schwere Spindeln) ändert sich bei einer im herkömmlichen Spinnablauf zunehmenden Bewicklung. Die Bewicklung wirkt sich bei den leichten Spindeln durch den vermehrten Luftwiderstand als Schwungdämpfer aus.

Bei der Messung der Laufzeit oder Drehdauer der Spindeln bei einmaligem Andrehen verhält es sich nun genau umgekehrt: leichtere Spindeln haben eine weitaus kürzere Laufzeit als schwerere (Fig. 7 und 9). So laufen die schweren Spindeln mit 124-147 g Gewicht fast 1 Minute lang, während die mit um 10-15 g sehr leichten Exemplare teilweise nur 15-20 sec. laufen.

Ergebnisse

Gesamt gesehen hat das Gewicht der Spinnwirtel und damit die Leistungsfähigkeit, die Drehfrequenz und die Laufzeit einen direkten Einfluss auf den Verwendungszweck der Spindeln (und Wirtel) unter der Voraussetzung, dass sie frei hängend verwendet wurden.

Die große Geschwindigkeit, mit der leichte Spindeln den Faden drehen bei gleichzeitigem geringem Gewicht ist etwa für die Herstellung von dünnen Wollfäden von Vorteil, da dünne Fäden (etwa 0,2-0,4 mm dicke) bei vergleichbarer Länge und gleichem Drehwinkel viel mehr Umdrehungen benötigen als etwa 1,5 mm dicke. Der Nachteil bei sehr leichten Spindeln, dass öfter angedreht werden muss, ist durch die große Drehfrequenz etwas gemindert.

Es ist für die Herstellung von sehr dicken Wollfäden (ab 1,5 mm) wichtig, dass die Spindel eine große Masse und Trägheit besitzt, die einen langen gleichmäßigen Lauf garantiert. Dass schwere Wirtel eine geringere Drehfrequenz aufweisen, stört wenig, da für dicke Fäden in einer in einem Arbeitsgang verziehbaren Fadenlänge nicht so viele Umdrehungen nötig sind, um den Faden zu stabilisieren.

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Curriculum vitae

Born in Linz, Austria, 1974, study at the Department for Pre- and Protohistory of the University Vienna (Mag. phil. 1999). Editor of the periodical "Archäologie Österreichs" of the Austrian Society for Pre- and Protohistory.
Main interests and projects are the Stone Age (Neolithic), Experimental Archaeology, prehistoric textiles. I presented spinning and tablet-weaving at various events.
Current projects: Analysis of artefacts from Hallstatt, experiments and reconstructions of prehistoric textile techniques (spinning, tablet-weaving ...)

Bast before Wool: the first textiles

Antoinette Rast-Eicher

Abstract

Weaving begins in Central Europe not in the Late Neolithic, but at latest at the end of the 6th millennium BC: this is deduced from early flax finds, spindle whorls and loom-weights. First, textiles were made of plant fibres; wool appears probably in the Late Neolithic, but certainly in the Bronze Age. At the end of the Bronze Age all textile techniques used during the Iron Age like twill and tablet weaving were already settled.

Die Weberei in Mitteleuropa beginnt nicht erst im Jungneolithikum, sondern viel früher, spätestens im ausgehenden 6. Jahrtausend v. Chr: diese Erkenntnis können wir durch die Interpretation der frühen Leinenfunde, Spinnwirtel und Webgewichte gewinnen. Die ersten Gewebe wurden aus Pflanzenfasern hergestellt; die Wolle erscheint vermutlich schon im ausgehenden Neolithikum, sicher aber in der Bronzezeit. Am Ende der Bronzezeit sind alle in der Eisenzeit verwendeten textilen Techniken wie die Köperbindung und die Brettchenweberei schon bekannt.

The following article gives a short overview of early textile history in Europe up to the Hallstatt period. New methods, new finds and many new investigations in textile archaeology have opened a much larger chapter in the history of a major aspect of prehistoric daily life: basketry and textiles[1]. The most important steps in development leading to Iron-Age weaving will be described, beginning a long time before the well-known finds from the Central European lake-dwellings.

Palaolithic/Mesolithic period

During the Palaeo- and Mesolithic period there is little evidence of basketry, a handful of finds scattered all over Europe: in the Palaeolithic period there is some cordage, one piece from Lascaux (F), one from Gönnersdorf (D), and imprints from Pavlov (CS), strings and others which may be twining[2]. With the exception of the string from Lascaux (F) all remains are imprints; the exact technique is very difficult to judge in such imprints – the interpretation of „weaving“ especially is problematic. Nevertheless, treebast has certainly been processed and used at that time for cordage and some basketry.

In the Mesolithic period, too, there is little evidence such as the two coiled baskets from southern Italy[3], the fishtrap and the twined receptacle from Noyen-sur-Seine (F)[4], the knotless netting from Tybrind Vig (DK), the cordage from the Island of Ære (DK)[5], or the nets from Friesack (D)[6].

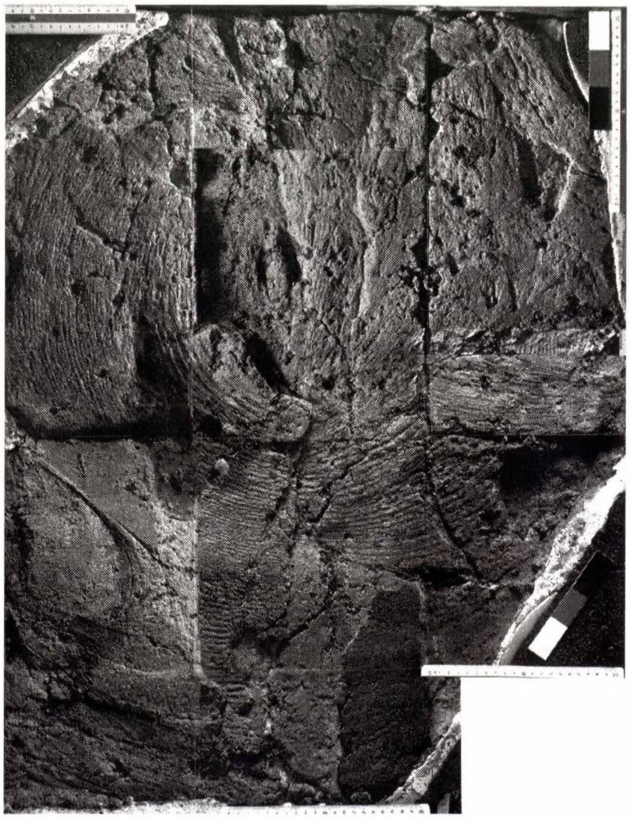

Fig. 1: The coiled basketry from Hoge Vaart (NL) (Photo: L. Klimbie, Voorschoten).

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[1] The technical descriptions are based on: Seiler-Baldinger 1991.

[2] Adovasio et al. 1996: 526-34. – Soffer et al. 2000: 812-21.

[3] Boscato et al. 2003: 127-131.

[4] Mordant 1987-90: 17-38.

[5] Bender Jørgensen 1992: 159 f.

[6] Gramsch 1989: 23-27. The excavation methods there have been adapted – they excavated with magnifiers! – to be able to find such fine organic remains in the soil.

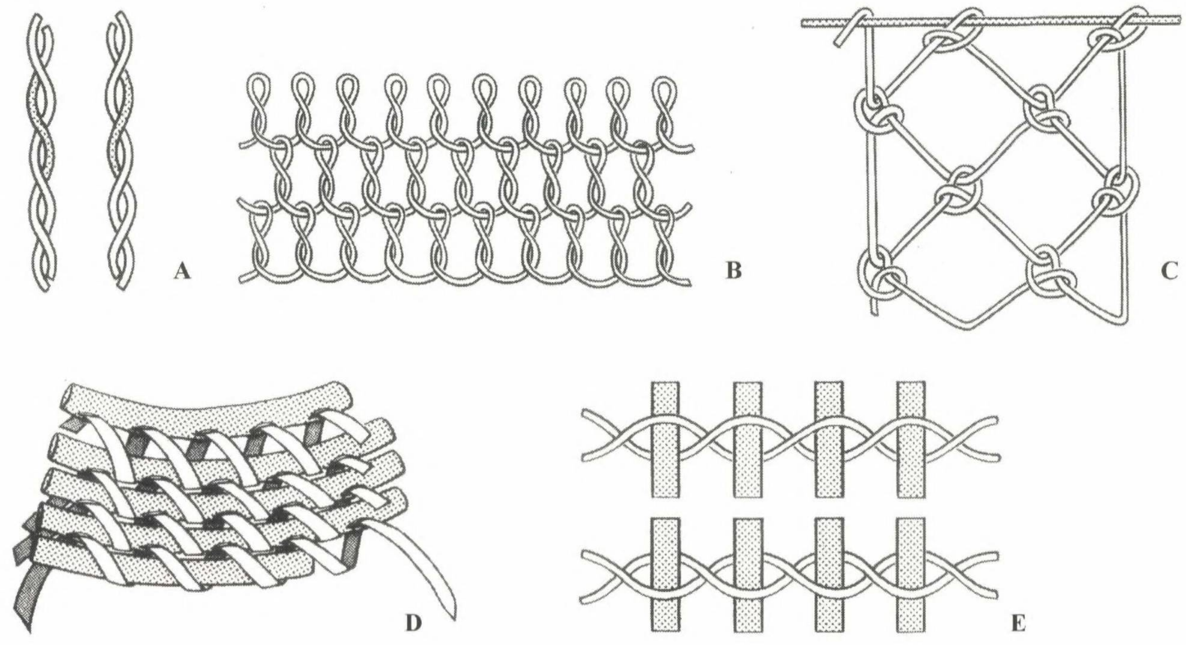
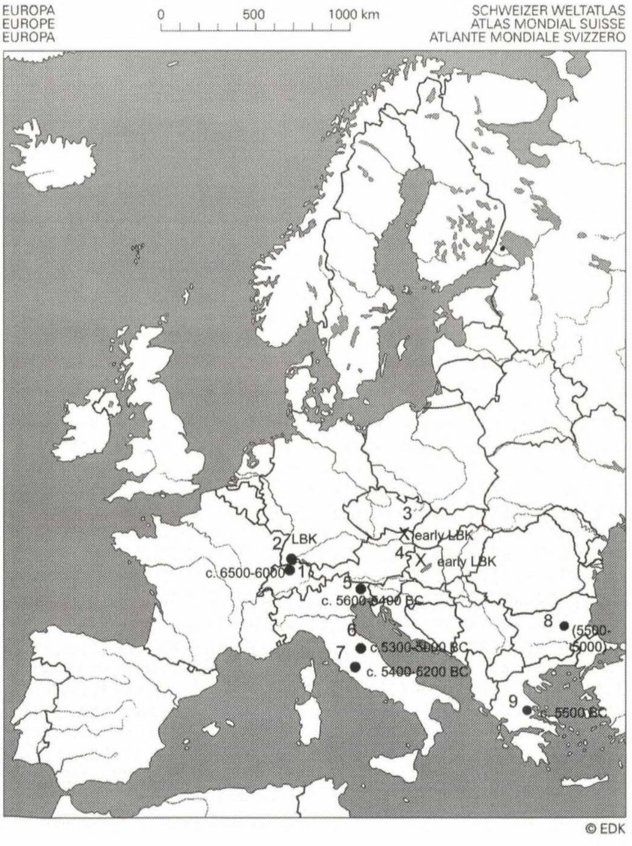


Fig. 2: Mesolithic basketry techniques. A: cordage. – B: knotless netting. – C: netting. – D: coiling. – E: 3-dim. twining (based on Rast-Eicher 1997).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9 c. 5500 BC
© EDK

Fig. 3: Early Neolithic flax remains in Central and Southern Europe, 1: Wallisellen-Langachermoos (CH), 2: Hilzingen-„Forsterbahnried" (D), 3: Strögen (A), Neckenmarkt (A), 5: Sammardenchia (I), 6: San Marco di Gubbio (I), 7: La Marmotta (I), 8: Chevdar (BU), 9: Sesklo (GR), ●: flax found, X: no flax remains (© A. Rast-Eicher).

One example may illustrate how such basketry is usually found just by accident. Dated to the change from the Mesolithic to the Neolithic period an imprint of a very large coiled basket has been found in Hoge Vaart (NL), a place where they used to hunt birds near the sea[7]. A big block was taken out in plaster to save the coarse and fragile pottery around a fire-place. The block was turned over in the laboratory for further excavation, starting from the bottom. The restorer found extensive impressions because the layers separated just there. These are probably remains of a sitting mat with a diameter of at least one meter. Small bits of organic material could be identified as birch (*Betula sp.*) for the coil and grass (*Gramineae sp.*) for the wrapping (Fig. 1).

The techniques applied are limited: cordage, knotless netting, netting, three-dimensional twining and coiling. The mesolithic objects are sitting mats, little bags, fishtraps and fishing nets. There is no two-dimensional twining nor weaving, and as far as we know no clothing made in a basketry technique. The fact that two-dimensional twining is missing shows that the objects have not been made on a frame. The raw materials are all made of plant fibres: tree-bast, grass, branches and roots (Fig. 2).

Neolithic period

(New) Raw material

Tree-bast was still in use during the Neolithic; it was the most important fibre until the beginning of the Bronze

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[7] Hamburg et al. 2001.

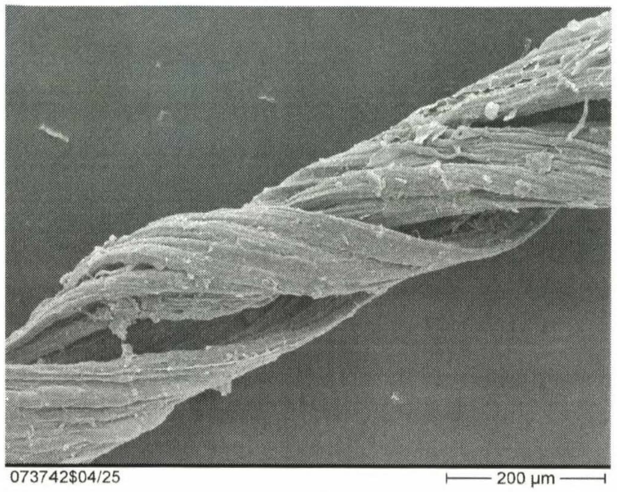

Fig. 4: Spliced linen yarn from Muntelier (CH/FR), excavation 2004, late Neolithic, stripes of unretted flax fibre bundles visible (© A. Rast-Eicher).

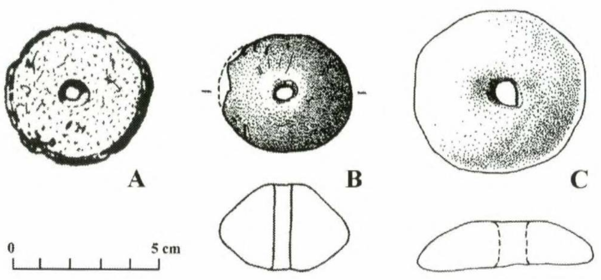

Fig. 5: Early neolithic spindle whorls, A: Bescehely (H), Starčevo-culture. – B: Hilzingen-„Forsterbahnried", pit of the LBK-culture dated to 5.259-5.063 BC cal. – C: Younger Neolithic discoïd spindle whorl, Zürich-Mozartstrasse, Cortaillod-culture, c. 3.900 BC. (Pictures based on: A: Kalicz 1990: pl. 45/1. – B: Fritsch 1998: Taf. 25/4. – C: Gross et al. 1992: Taf. 290/1).

Age, used for many different objects, including clothing. We can speak of a „bast-culture". The most popular representative is certainly „Ötzi", the iceman who wore a mantle of grass made in twined technique. Bast could be used either as unretted strips or retted and spun. The coming of a new fibre did not much change the use of bast. Flax was processed like tree-bast, unretted or retted (see Fig. 4).

The cultivation of flax (*Linum usitatissimum* L.) arrived with settlements and the invention of pottery, as well as the the breeding of sheep and goats[8]. This period of early farming is very interesting, and probably the starting point of weaving. First farming is dated in the Near East to the 9th millennium BC (first steps in the 10th millenium BC)[9], in Central Europe certainly by the 6th millennium BC. Palynological research and a few macroremains even point to the 7th millennium[10]. Flax (*Linum usitatissiumum* L.) remains show well the beginning of this new fibre in Europe (Fig. 3: geogr. distribution of early flax remains). There are few remains south of the Alps which may be a research problem, especially in France. In southern France, the Early Neolithic layers are found in caves, and further north the early neolithic culture of „La Hoguette" provide almost no remains, and very little pottery. Recent excavations in Italy have shown that flax is certainly present from the 6th millennium BC[11].

North of the Alps there is one very early find in Switzerland, from Wallisellen-Langachermoos (CH/ZH) dated to the the second half of the 7th millennium BC[12] (Fig. 3, no. 1). Other flax finds appear at the end of the 6th millennium BC in farming sites of the Linearbandkeramik-culture (LBK). In many LBK-layers flax seeds have been found, so flax seems at that time quite wide-spread. For example, there is one noted on the map Fig. 3, the spot no 2 at Hilzingen-„Forsterbahnried" (D)[13]. This site is dated to 5.200-4.500 BC cal. Further east in the Czech Republic or in Hungary the early LBK-layers or other cultures of the second half of the 6th millennium BC in many cases produce no flax, such as Neckenmarkt (A), Strögen (A) (LBK), sites of the Bükker-culture or Starčevo-culture[14]. Two examples are noted on the map (Fig. 3/no 3, 4). Important and interesting is the fact that cereals such as emmer have been found, as well as spindle-whorls and loom-weights (see below).

The early flax finds in Central Europe and the lack of them in Eastern Europe show that the direct influence of the cultivation of flax probably becomes more important in Italy and Southern France via the Mediterranean. The direct influence of the LBK-culture is therefore not that important in view of the much earlier flax finds in Central Europe. How this southern influence affected the indigenous development has to be discussed.

The beginning of flax cultivation can be set 2000 years earlier than the well-documented agriculture in the lake-dwellings of Central Europe. In the early lake-dwelling Egolzwil CH/LU (about 4.300 BC) the cultivation of flax seems still marginal[15]. The importance rises considerably in the 4th millennium with a peak in the layers of the Pfyn and Horgen culture[16].

As a source of textile fibre sheep and goats do not seem very important in early farming. Their presence is in fact highest in settlements before 4.000 BC (in Switzerland) – 97 % of the bones found in the settlement of e.g. Sion-Planta (CH/VS) dated around 5.000 BC are from domesti-

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[8] General information on the early Neolithic see: Gronenborn 2003: 79-91.

[9] Stordeur 2000: 33-62.

[10] Erny-Rodmann et al. 1997: 27-56.

[11] Rottoli 2003: 65-71.

[12] Erny-Rodmann et al. 1997: Fig. 5. Dated to 6.500-6.000 BC cal.

[13] Fritsch 1998: 157 f.

[14] Lenneis and Lüning 1990. – Lichardus 1974. – Kalicz 1990.

[15] Bollinger 1994.

[16] Brombacher and Jacomet 1997: 220-291.

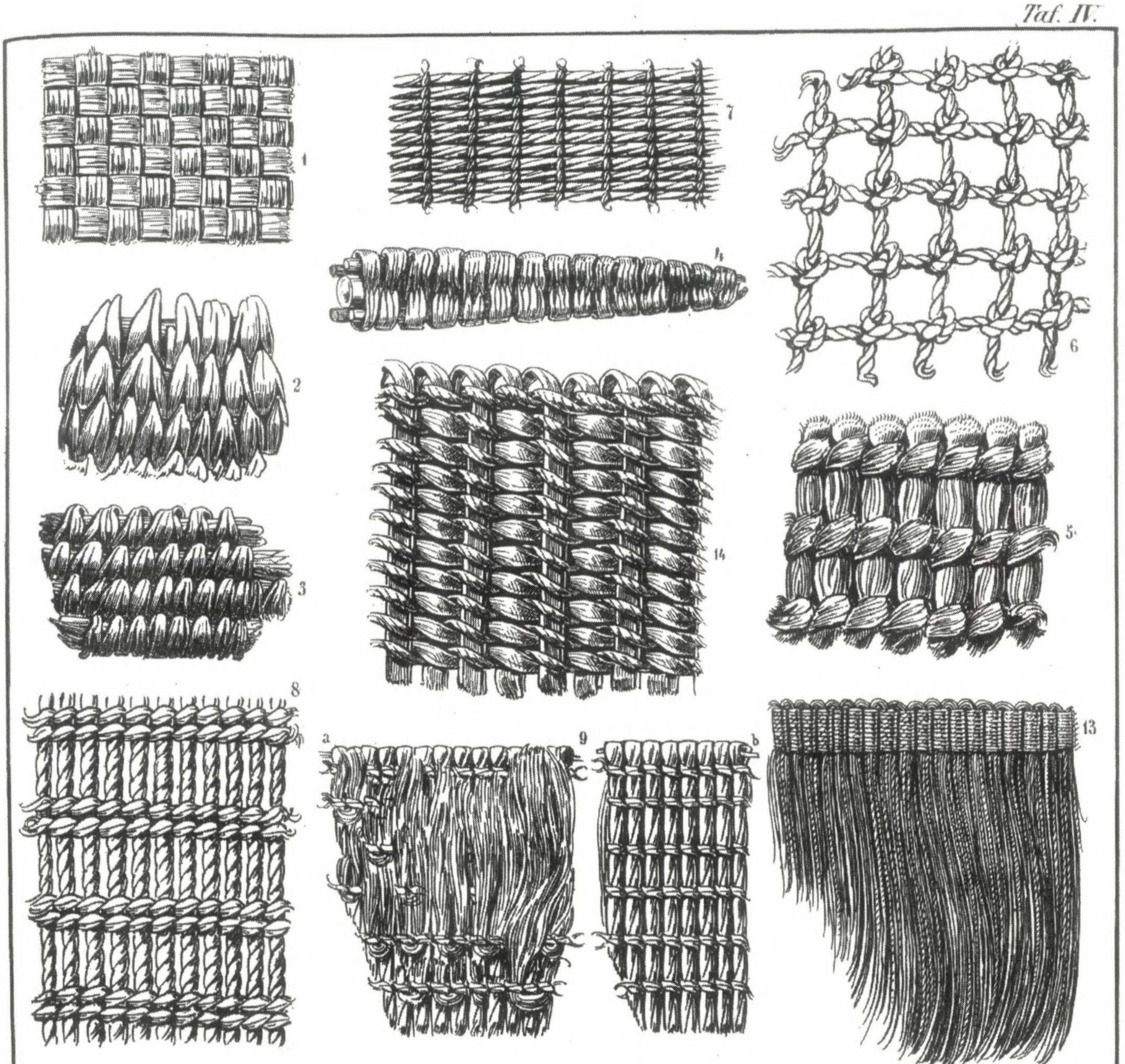
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Fig. 6: Finds from Wetzikon-Robenhausen (based on 3. Pfahlbaubericht, Antiquarische Gesellschaft Zürich, 1860: Taf. IV).

cated animals (half of them from sheep/goat) – but according to their slaughtering age they were kept for meat and not for wool. In eastern Swiss lake-dwellings this proportion in terms of the bones decreases in the Pfyn culture to about 10 % and rises again towards the end of the Neolithic. In western Switzerland sheep/goats had more importance throughout the Neolithic. Until the end of the Neolithic period there are no signs of wool production. This changes afer 2.800 BC when the number of adult female animals rises among sheep which could be explained in terms of milk and wool production[17].

Processing of the fibres

At that time a new tool was invented, the spindle with spindle whorl. We in fact do not know for which fibre it was invented, for animal or plant fibres. Considering that contemporary flax grew only 1/3 of the modern size, we may assume that the spinning of this fibre was much more comfortable with a spindle than without. Another fact is that there are spliced single yarns found on spindles, which are made of unretted fibres (Fig. 4). This technique implies the spinning of tree-bast fibres with the spindle before the cultivation of flax[18]. Such continous threads would be needed for finer basketry in twining as well. Another argument for the early spinning of plant fibres (first tree-basts, then flax) is the fact that these early spindles are quite large (and heavy) and therefore much more suited for plant fibres than for animal fibres (Fig. 5 and „Bronze Age“). One neolithic spindle with whorl has been found with the spun bast thread still wrapped on it (Arbon-Bleiche TG, 3.380-3.374 BC). The spindle is made of hazel, the whorl has the form of a disc (diameter: 5 cm), and the thread is made of tree-bast (lindenbast, z-spun, 0.7 mm)[19].

There are very early finds of spindle whorls, especially in the LBK-culture around 5.000 BC, and in eastern Europe in early Neolithic layers. Some of them are very elaborate, others just made of a recycled piece of pottery (Fig. 5A). The ones from Hilzingen-„Forsterbahnried“ have been found in a pit with LBK pottery, and dated by ^{14}C to 5.259-5.063 BC cal.[20] (Fig. 5B) – these whorls are at least 700 years earlier than the first ones in the lake-dwellings (Fig. 5C). The size of the whorls seem to be very similar to the early whorls found in Swiss lake-dwellings, which are often discoid[21].

Most of the Neolithic whorls are made of unburnt clay or stone; but there was an absence of them in the Pfyn culture (3.800-3.600 BC). They seem to have been made of wood, as some remains have now proved[22]. The spindle brought the means of spinning a continous thread which is one of the conditions for fine yarn and for weaving.

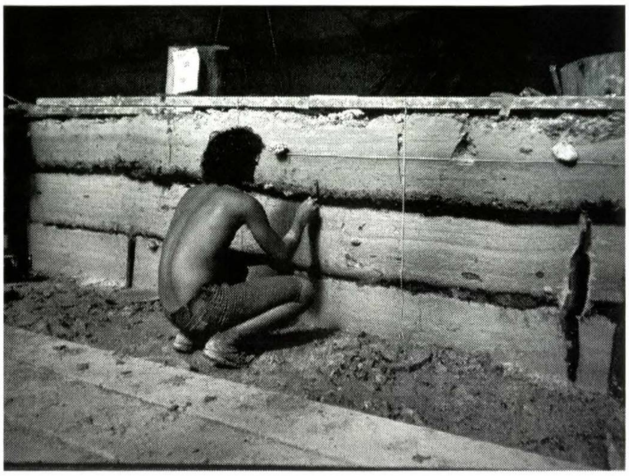

Fig. 7: Stratigraphy of the late Neolithic lake-dwelling of Zürich-Mythenquai (CH/ZH) (© A. Rast-Eicher).

Neolithic lake-dwellings

The first (woven) textiles – despite impressions on pottery of the LBK-culture[23] – have been found in lake-dwellings. The lake dwellings start in the mid 5th millennium, in Switzerland in Egolzwil (LU, 4.300 BC). Many other sites at the Swiss lakes are dated beween 4.000 and 2.600 BC providing a lot of organic material[24]. The oldest woven textile has been found in the early Cortaillod layer from Zürich-Kleiner Hafner, dated around 4.100 BC[25]. It is an archaeological problem that we do not have remains (except impressions) of the 6th/first half 5th millennium BC.

One of the most interesting sites is Wetzikon-Robenhausen (ZH), a site at the lake of Pfäffikon near Zürich which was discovered 150 years ago. Jakob Messikommer who found the site was working in the peat bog, documenting and collecting the various objects.

From 1856 onwards, the archaeologist F. Keller published this material in the journals of the „Antiquarische Gesellschaft in Zürich“ (Fig. 6). The textiles and basketry became famous after their publications by Emil Vogt in 1937[26]. Recent ^{14}C-analyses have meanwhile dated one fine textile fragment from Wetzikon-Robenhausen to the Pfyn-culture (SLM 559: 3.901-3.671 BC cal.), the famous textile from Irgenhausen to the Middle Bronze Age (1.685-1.493 BC cal.)[27].

Vogt's publication emerged during the time of great interest in textiles and costume, when the Danish Bronze Age textiles were published by Broholm and Hald[28]. Looking through these very old journals from Zürich, it was interesting to see how carefully Messikommer and Keller had observed basketry and textiles. For instance, it was clear to

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[17] Schibler 1997: 220-291, 40-121, especially 77 f.

[18] Spun Neolithic bast thread in: Rast-Eicher 2003: 55-60.

[19] de Capitani et al. 2002: 119, Fig. 147/3.

[20] Fritsch 1998: Taf. 25.

[21] Rast-Eicher 1997: 322. – Hafner and Suter 2003: Fig. 5.

[22] Tobler 2002: Taf. 26/1.

[23] Kostelníková 1985: 197 f.

[24] Hafner and Suter 2003.

[25] Bazzanella, Mayr and Rast-Eicher 2003: 87-97, Fig. 1.

[26] Vogt 1937.

[27] Bazzanella et al. 2003: cat. no 41 and 39, p. 231 and 227.

[28] Broholm and Hald 1935.

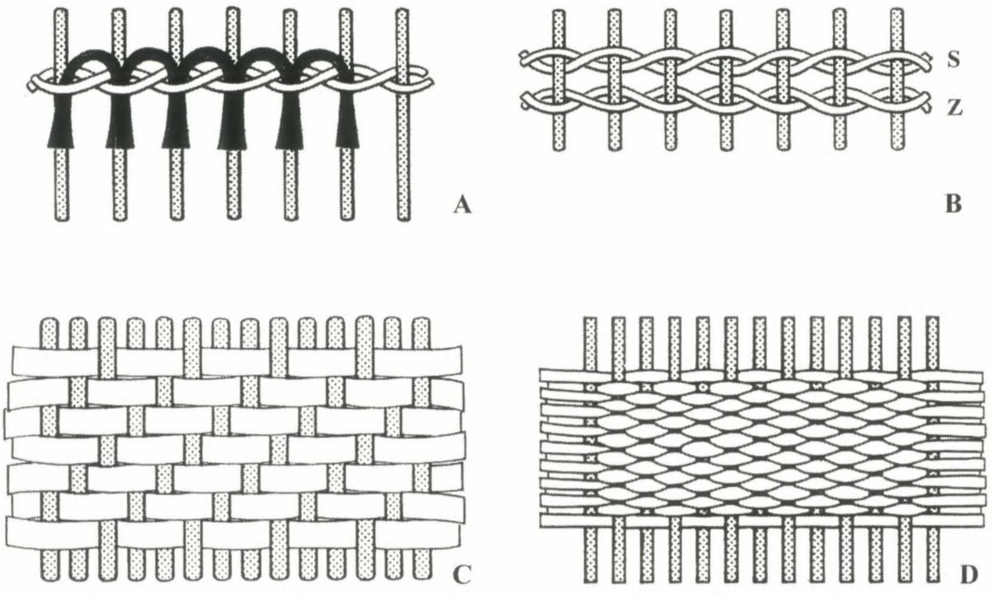

Fig. 8: Neolithic, new techniques. A: twining with pile. – B: 2-dim. twining. – C: plaiting (1/1 or 2/1). – D: weaving (based on Rast-Eicher 1997).

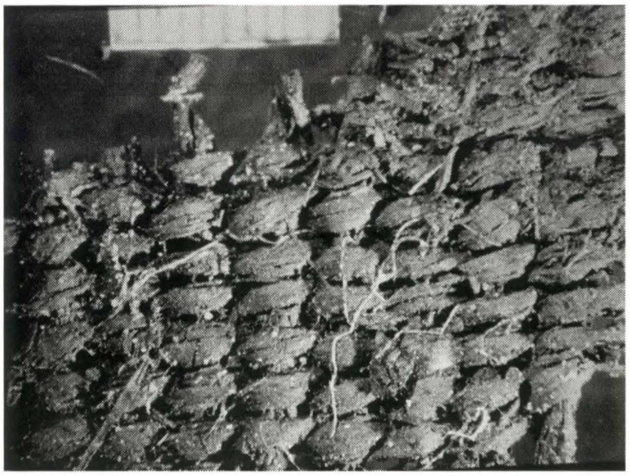

Fig. 9: Twined basketry, Zürich Kanalisation-Seefeld, FK 804, Corded Ware, c. 2.600 BC (© A. Rast-Eicher).

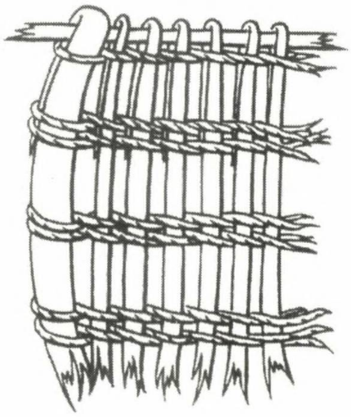

Fig. 10: Starting border of a twined basketry from Zürich-Mozartstrasse (CH/ZH) (based on Rast-Eicher 1997: Fig. 309).

them that the loom-weights were parts of the warp-weighted loom. Messikommer even remarks that on the evidence of these weights looms had been seen in nearly all houses, and he concluded that every family probably did its own weaving[29].

This site is still very special. A sondage in 1999 has shown how well the organic material of that site is still preserved[30].

In the years after Vogt's publication early textiles have not been a research subject in Switzerland. This changed with the excavations which have taken place in response to larger constructions or enlargments of ports at the lakes since the late 1960s. They were also the starting point of underwater archaeology, now a well established part of Neolithic excavations, and of the excavation of larger quantities of Neolithic basketry and textiles in Swiss lakes[31].

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[29] *„Herr Messikommer fand nämlich in demselben [Raum] an sechs verschiedenen nach der Entfernung entsprechenden Stellen je eine Mühle von der in den früheren Berichten beschriebenen Art, Haufen von Getreidekörnern, Stücke von Geweben, Geflechten, Vorräte von unverarbeitetem Flachs stammt den zum Webstuhl gehörigen Tonkegeln, auch grosse Steine, die den Herd gebildet hatten. Es ist also klar, dass jede Hütte von einer Familie bewohnt wurde und ihre eigene Vorrichtung zur Zubereitung der Lebensmittel und Herstellung der Kleider besass.“* F. Keller 1866: 248.

[30] Altorfer and Médard 2000: 35-74.

[31] Bazzanella and Rast-Eicher 2003: 23-30.

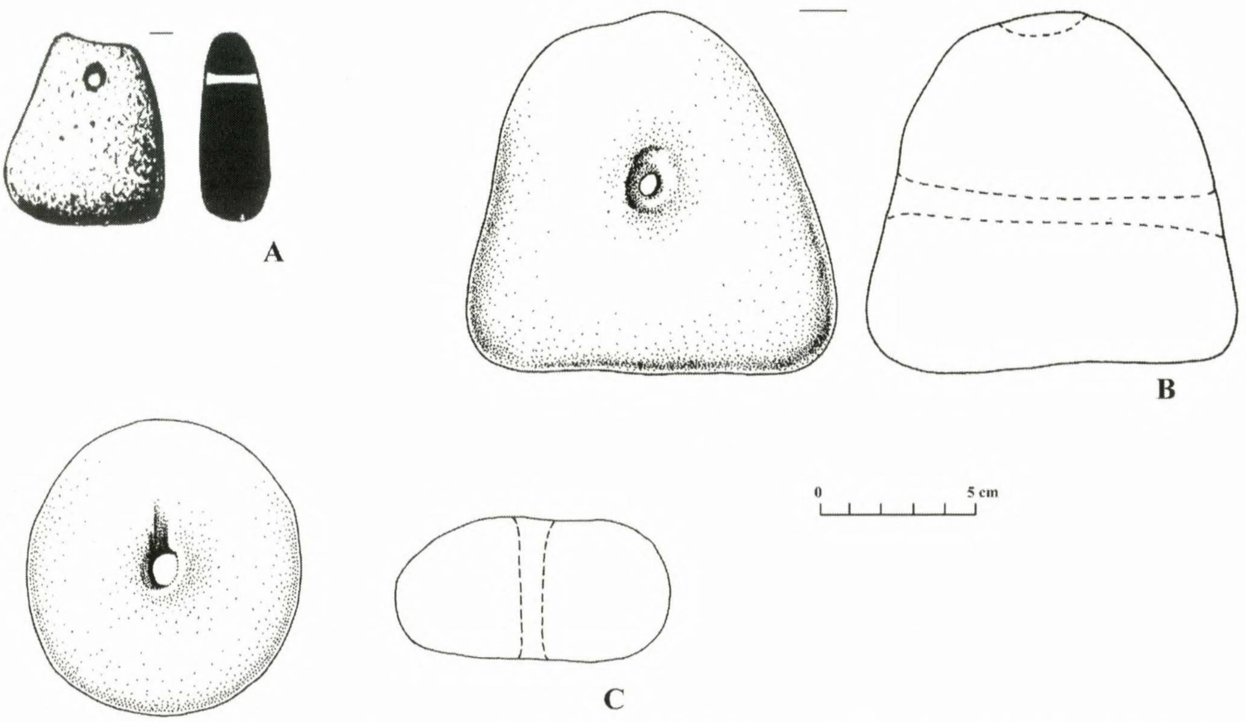

Fig. 11: Neolithic loom-weights. A: Lánycsók (H), early Neolithic, Starčevo-culture. – B: Zürich-Mozartstrasse (CH/ZH), younger Neolithic, Pfyn-culture, c. 3.650 BC. – C: Zürich-Mozartstrasse (CH/ZH), late Neolithic, Corded Ware, c. 2.600 BC (Pictures based on: A: Kalicz 1990: pl. 17/5. – B: Gross et al. 1992: Taf. 287/2. – C: Gross et al. 1992: Taf. 289.9).

The layers in such lake dwellings are preserved because of the wet environment and because they are airtight (Fig. 7). These soils preserve plant fibres, whereas in the acid soils in northern Europe animal fibres but nearly no plant fibres have been found. The thickness of the layers can be very different which affects the preservation of organic material. Thin layers will have much less organic material, which includes flax seeds.

Basketry techniques

The techniques known in the Mesolithic period were still used during the Neolithic: knotless netting, knotted nets, twining technique (three-dimensional) and coiled basketry. But there are also new techniques now: two-dimensional twining, plaiting and weaving. Sprang, a technique known in many cultures in ethnographic contexts, is not represented in European prehistoric basketry.

The basic crafts were known from earlier times, especially how to process plant fibres, first tree-bast and later flax (Fig. 8).

In the region of Zürich about 1.000 basketry and textile fragments from over twenty sites has been found up to 2004 (most of them Neolithic), so that a statistical interpretation of the different techniques is possible[32]. Some 25 % of these finds were made in twining, which is the most important technique used for various objects. There is three-dimensional twining which has been used for e.g. hats. There is also two-dimensional twining which on first sight can have the aspect of a woven textile because it is dense and flexible (Fig. 9). Their starting border resembles the starting borders of woven textiles and is made for a vertical system (Fig. 10). Moreover, the objects are so large that one could not think of another way of production for such twining than with a fixed warp. Certainly the twining is in the weft and not the warp[33]. This supposition was proved in 1999 when a twined object was excavated in Wetzikon-Robenhausen, with loom-weights still fixed to the warp threads[34]. We now have so called „loom-weights“ used for a basketry technique as well. As flax remains lacking on many sites where loom-weights are present, as well as spindle whorls (see above), we must assume that these large two-dimensional objects in twined technique could have been made technically before weaving, and that weaving developed from this technique[35]. The small weights from the Starčevo-culture in Hungary (as early as the LBK-culture) are too small and therefore too light to weave flax, but enough for a twining warp (Fig. 11A).

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[32] Rast-Eicher 1997. – A manuscript from 1994 by A. Dietrich and A. Rast-Eicher about the finds from Zürich with a catalogue and more details could unfortunately not yet be published .

[33] J. Winiger postulated in his article about early textiles, that the weft was twined. He turned around drawings which are clearly the other way up: Winiger 1995, 119-187, especially Fig. 46.

[34] Altorfer and Médard 2000.

[35] Rast-Eicher 1997: 322 f.

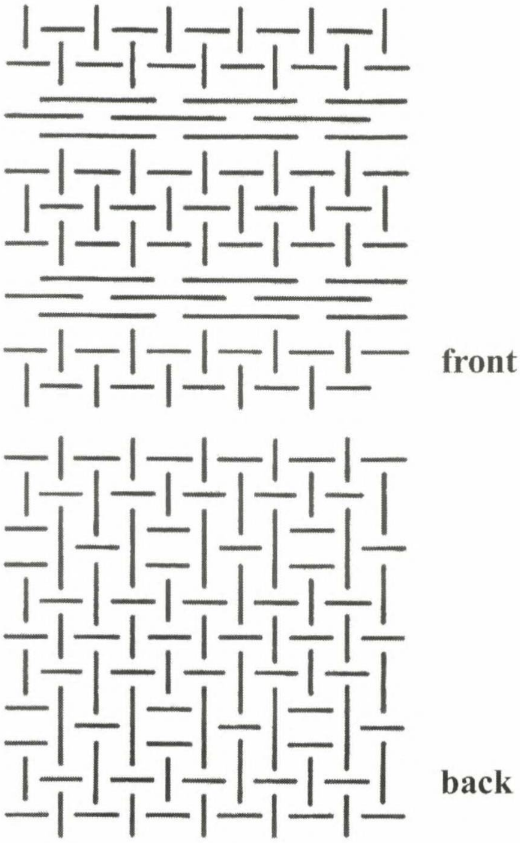

Fig. 12: Textile with stripes, Wetzikon-Robenhausen (CH/ZH), SLM 554, 3.650 BC (© A. Rast-Eicher).

Fig. 11B shows a typical large weight from a Cortaillod layer, heavy enough for weaving, Fig. 11C shows the late neolithic round type (Corded Ware), which is lighter and more adapted for wool.

Woven textiles

The known Neolithic textiles are all made of flax (animal fibres are destroyed in the alkaline soils of the lake-dwellings) with plied yarn and woven in tabby. The threads are usually very fine, ranging from 0.3 mm to 1 mm. The first attested is, that Central European textiles are not beginners` work at all. They show a highly developed technique of fibre production, spinning and weaving. Where borders have been found, they are often reinforced, both the starting borders and the selvedges. The end is often made with fringes. There are large and narrow textiles. The number of narrow textiles found gives the impression that larger sizes could not or were not be made. But this was again an archaeological problem: narrow textiles are very often rolled up and have therefore a better chance to survive in the layers. Now there are large textiles known from the Cortaillod culture, dated around 3.800 BC[36]. Some textiles are patterned, either with 3-ply yarn or with supplementary threads in twill, which are inserted by hand (Fig. 12).

The starting borders show how the warp was prepared. First they made a small separate band in normal band weaving or in later times in tablet-weaving (Fig. 13). The weft of that band was on one side long loops to be used as future warp threads. Such starting borders have two threads in each shed. Then the band with the long warp threads was fixed on the loom (Fig. 14). In order to avoid the need to cut the loops while fixing every second thread on the heddle, they could just cross two loops (Fig. 15). This crossing is visible in the starting borders of Neolithic textiles. It is visible on several textiles, narrow ones as well as larger ones.

One is a textile from Niederwil-Gachnang (CH/TG) dated to the Pfyn culture around 3.700 BC. For the first centimeters both selvedges have been preserved; the width is 9.4 cm. The starting border clearly shows the crossing of the warp[37]. Another, younger textile is dated in the Schnurkeramikkultur (2.680 BC) and has been excavated in Zürich-Mythenquai (Fig. 16). It is a large textile with knotted pile[38]. The preserved border is a starting border with crossing of the warp threads. This type of starting border is used throughout the Iron Age until Medieval times as long as the warp-weighted loom was in use. It has been documented also on the Bronze Age textiles in Northern Europe[39]. The narrow textiles with the same type of starting border and reinforced selvedges must have had a special function like e.g. leg wrappings. Otherwise such complicated selvedges which need three changes of the shed on each side make no sense.

The warp-weighted loom still existed in northern Europe in the 20th century[40]; the archaeological evidence of such loom-weights in Central Europe lasts until the late Middle Ages.

Clothing

We can assume that for a very long time even in the Neolithic leather or skin were the basic constituent of clothing, even at a time when linen garments were made, because wool was probably not used for textiles (see above) – „Ötzi" is a typical representative. Tree-bast were useful for rain-coats or hats, but not to keep somebody warm.

In the lake-dwellings textiles for clothing have certainly been found. The very fine and decorated textiles from Wetzikon-Robenhausen dated around 3.700 BC have to be interpreted like that. Later, there is a very fine textile from Zürich-Kanalisation Seefeld dated around 2.600 BC (Corded-Ware) with an sewn band on which a button hole is

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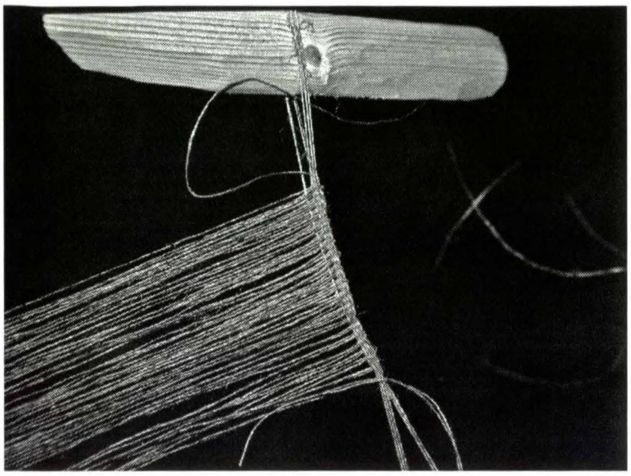
[36] Rast-Eicher 2003.

[37] Hundt 1991: 251-272. The crossing is omitted in the drawing on Fig. 225, but visible on the photograph.

[38] Rast-Eicher 1992: 56-70, Figs. 1-6, 9.

[39] Hald 1981, 158 ff.

[40] Hoffmann 1964.



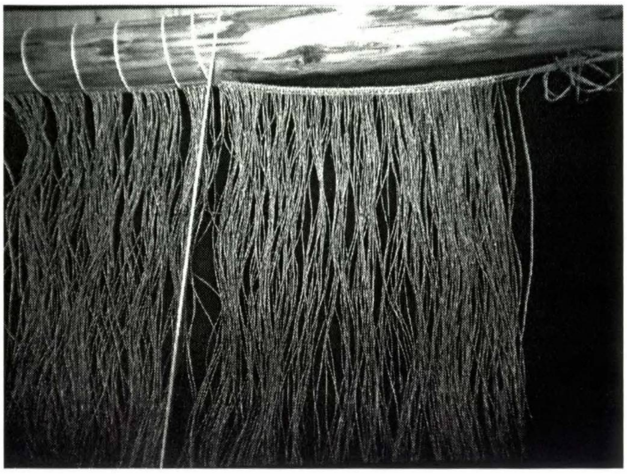
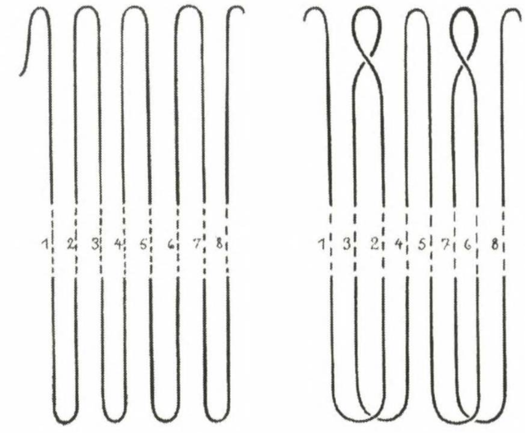


Fig. 13: (left) Reconstruction of a Neolithic starting border (© A. Rast-Eicher).
Fig. 14: (right) The starting border is fixed on the loom (© A. Rast-Eicher).



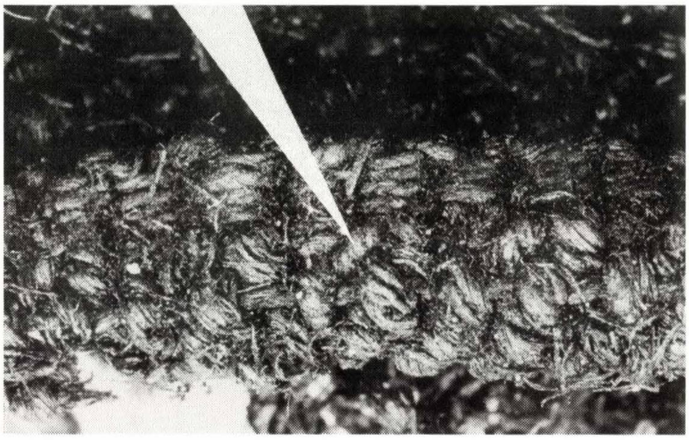


Fig. 15: (left) Crossing of the warp threads after the starting border (based on Hald 1980: Fig. 201).
Fig. 16: (right) Starting border with crossing of the warp-threads, Zürich-Mythenquai (CH/ZH), FK 1375 (© A. Rast-Eicher).

fixed (Fig. 17). The size of the button hole corresponds to the size of buttons found in layers of the same period in Zürich and elsewhere. The buttons are made of bone, antlers or shells and are dated to the last Neolithic period, some from the Early Bronze Age[41] (Fig. 18).

These buttons disappear later in the Bronze Age, as soon as there is obviously another fibre and pins appearing – and later brooches – to fix the dresses. Pins are not ideal for linen garments because they would produce unreparable holes. Wool is much more flexible in a sense; pins therefore do not damage it too much. The buttons disappear for many hundreds of years – until Late Medieval times.

Further larger pieces of Neolithic garments are preserved: they have been found in Spain, in Lorca (Murcia). The fragments are made of fine linen with qualities of 15 or more than 20 threads/cm. There are a neck-opening and fringes at the end of the textile[42].

Dresses carved in stone...

In Sion (CH/VS), there are big grave-stones from large graves of the beaker-culture, the youngest Neolithic culture dated around 2.400-2.200 BC[43]. These stones are sculptured and show men with clothing, belts and sometimes pockets. The dresses are patterned with lines, triangles, rhombus. Some have belts with a loop at the end (Fig. 19). A belt which looks just the same as on the stele from Sion has been found in the Early Bronze Age settlement of Mo-

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[41] Hafner and Suter 2003: Fig. 10. The Early Bronze Age buttons are not on this table. Found in Sion-Petit Chasseur (CH/VS), but also in Savognin/Padnal (CH/GR) and in a grave from Singen (D).

[42] Alfaro 1992: 20-30.

[43] Gallay 1995, 105-112.

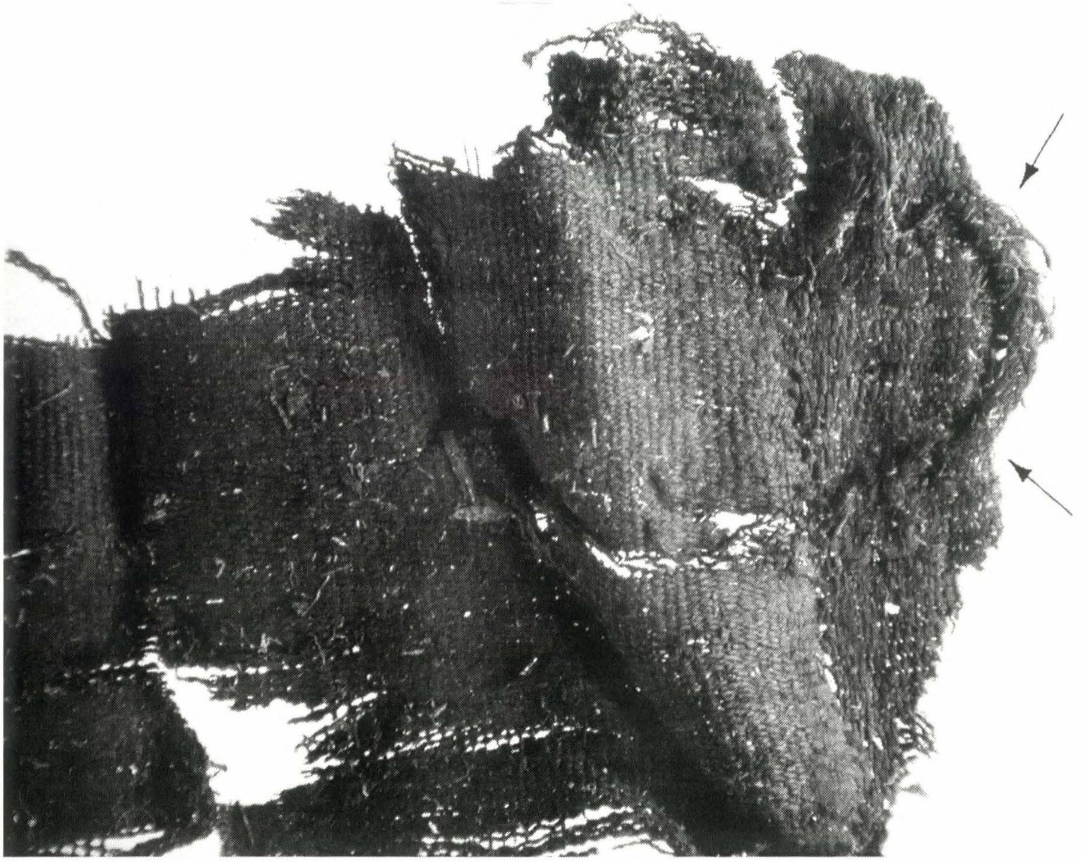

Fig. 17: Textile with button hole, Zürich-Kanalisation-Seefeld (CH/ZH, FK 2650), Corded Ware, c. 2.600 BC (© A. Rast-Eicher).

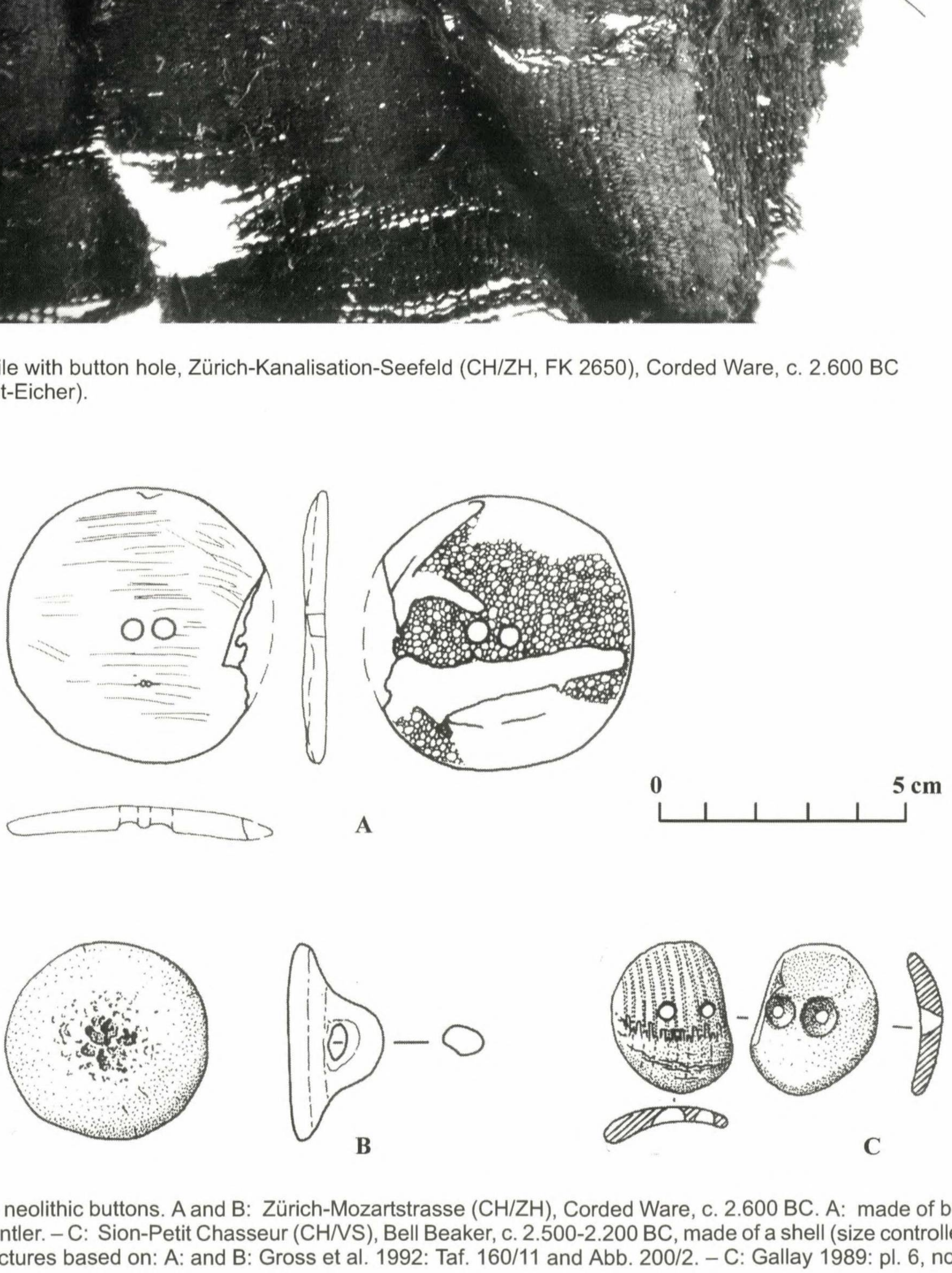

Fig. 18: Late neolithic buttons. A and B: Zürich-Mozartstrasse (CH/ZH), Corded Ware, c. 2.600 BC. A: made of bone. – B: made of antler. – C: Sion-Petit Chasseur (CH/VS), Bell Beaker, c. 2.500-2.200 BC, made of a shell (size controlled on original). (Pictures based on: A: and B: Gross et al. 1992: Taf. 160/11 and Abb. 200/2. – C: Gallay 1989: pl. 6, no 1881).

lina di Ledro in Northern Italy[44]. This shows that the depicted garment existed in reality.

Bronze Age

The Bronze Age brought a completely new tradition. Wool created new garments. The Neolithic „bast-tradition" was gone, even if some techniques like knotless netting remained. Objects of bast never again got the importance they had during the Neolithic period. Wicker-weave is the new basketry technique which appeared in the Bronze Age and which became very frequent[45].

During the latest Neolithic cultures and early Bronze Age there are some changes in raw material. As we do not have animal fibres in lake-dwellings because of alkaline soils (there two exceptions in the Bronze Age connected with metal[46]), we have to investigate other groups of material. The loom-weights change in the Neolithic from a normally large conical form with the hole at the top to round and lighter ones with a central hole. Furthermore, the spindle-whorls change from flat and heavy ones to biconical whorls. This change started in late Neolithic layers as at Arbon-Bleiche (Horgen-culture, 3.384-3.370 BC) on Lake Constance[47]. There, more than 10 % of the spindle-whorls are biconical, a form which is standard in the Bronze Age. The weight of the whorls ranges between 6 g and more than 80 g; which is the earliest site with such a variety. Lighter and more compact whorls have a faster rotation, and are therefore more appropriate for short fibres like wool.

Sheep/goat bones increase generally and become an average about four times more important than in the Neolithic settlements[48]. Sheep are larger, but still hairy – with an outer hairy coat and fine underwool. The slaughtering age is rising, a development coming from the use for milk and wool. The textile from the Middle Bronze Age settlement of Castione Marchesi (I) shows well the type of Bronze Age wool. There is fine underwool (now brown because of the soil, but originally white) and very large hairs which appear black (Fig. 20). As wool measurments of Swiss finds have shown, this type of wool will not change a lot until the early La Tène period[49].

The important source for Bronze Age textiles is shifting to the North[50]. Other textiles (wool or flax) are found all over Europe, but with the exception of the lake-dwellings of Ledro (I) not in bigger quantities[51]. The dating of these northern textiles is mainly in Danish Bronze Age II and III, which in Central European chronology corresponds to the Middle Bronze Age. In the acid soils of northern Germany and Denmark complete garments have been found in burials (oak coffins). They are nearly all of wool, with generally a low density of threads per cm, mostly 3-6, the same in rich or poor graves. Their characteristics are a dense and coarse weave, sometimes with pile, which shows that they are somehow imitating skin. There are

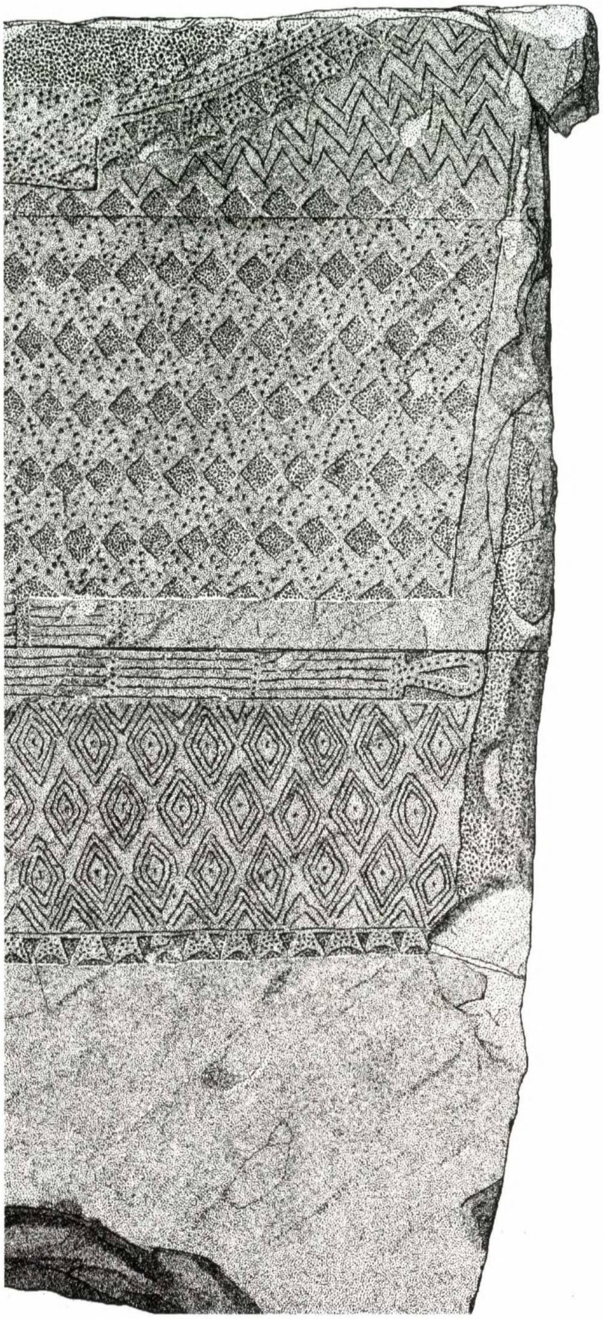

Fig. 19: Stele from Sion-Petit Chasseur, Dolmen MXI (Drawing: S. Favre, Département Anthropologie, Université Genève).

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[44] Bazzanella et al. 2003: 162 f.

[45] Rast-Eicher and Reinhard 1998: 285-290.

[46] Wool yarn in a metal ornament from Hauterive (CH/NE): Rast-Eicher and Reinhard 1998: Fig. 153. – Textile on a late Bronze Age sickle from Zürich-Alpenquai (unpublished).

[47] de Capitani et al. 2002: 115 ff.

[48] Schibler and Studer 1998: 181 f.

[49] A. Rast-Eicher, Iron Age textiles in Switzerland, in prep.

[50] Hald 1981. – Bender Jørgensen 1986. – Bender Jørgensen 1992.

[51] Some Ledro Textiles are published in: Bazzanella M. et al. 2003. The full publication is in prep.

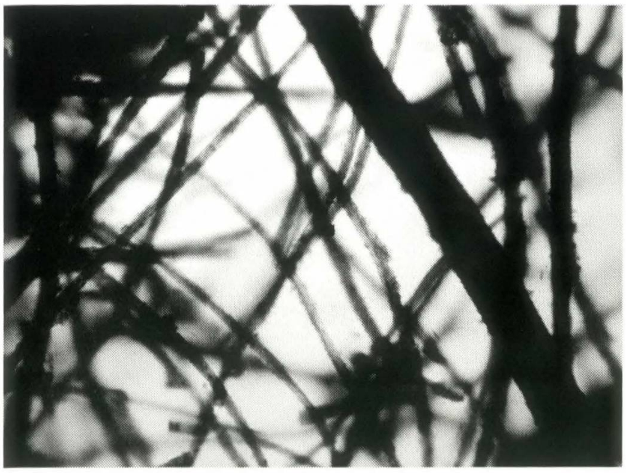

Fig. 20: Bronze Age wool from Castione Marchesi (I), with fine underwool and very large upper fibres (© A. Rast-Eicher).

large textiles like the Muldbjerg garment with a width of 211 cm, and a length of 131 cm, woven by two persons on the warp-weighted loom. Finer textiles from Voldofte made of plant fibre (nettle) show that finer textiles were at least known. It was probably just a matter of function of the textiles which quality was produced. The textiles with plaited endings like the one of Harrislee (D) or Egtved (DK) can have been woven on a tubular loom as well[52]. Men's caps of wool were partly made in a complicated construction of several layers.

The garments for women consisted of a long skirt or a fringed skirt (Egtved) and a shirt/poncho. The shirts have sleeves and body woven in one piece. Men wore a tunic sewn from different pieces, an oval cloak woven „in shape“ and a large textile (cover) made by two persons on the loom.

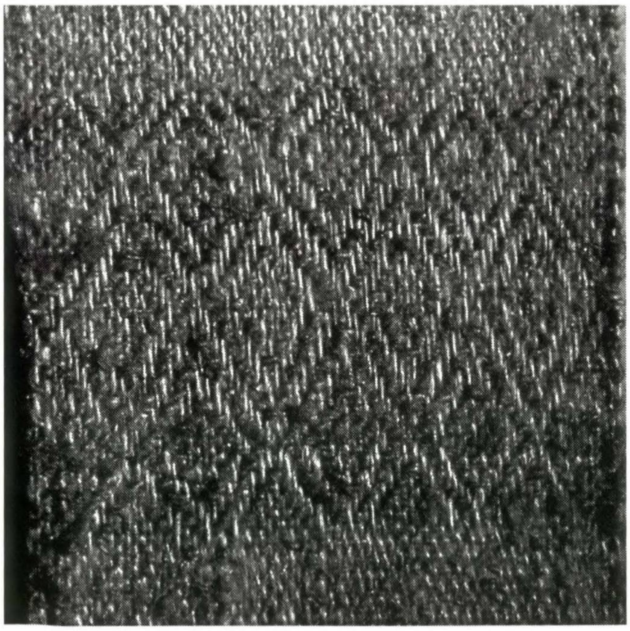

Fig. 21: Reconstruction of the early Bronze Age textile decorated in lozenge twill from Molina di Ledro (I), c. 2.100 BC (© Elena Munerati, Ufficio Beni Archeologici, Provincia Autonoma di Trento).

Twill appears in the Danish Late Bronze Age which corresponds to Central European Hallstatt period. But this new technology seems to appear earlier:

Rock carvings from the Val Camonica (I), dated to Early Bronze Age show clearly more than one heddle-rod[53]. And the Early Bronze Age textiles from Molina di Ledro (I) confirm that this technology was known by 2.100 BC. The lozenge design made in twill on the linen band (girdle)[54] corresponds to the design on the stele from Sion (Fig. 19) in Switzerland which is dated to the Beaker culture (2.400 -2.200 BC) (Fig. 21). Another piece fits very well what this stele shows, the 2 m long girdle from Ledro with a loop at its end – just like the one on the stele. Therefore we can assume that twill had been invented at the end of the Neolithic. This is also the time sheep become more frequent and the whorls lighter (see above). For the moment we just do not have the clear evidence because of the lack of woollen textiles in our lake-dwellings dated to the last Neolithic period. Twill doesn't make much sense for a linen textile except for special decoration (see above). By contrast with wool it completely changes the character from a stiff textile to an elastic one. And furthermore twill is very decorative. The woollen textiles woven in twill are normally not heavily fulled – and this is the case throughout the Iron Age and Early Medieval period.

As I mentioned earlier, pins changed the garments. Several different garments, warm and fine ones were possible, a material which could for most of the year replace skin. Very long pins seem to close a dress, such as the recontructions show made from the Early Bronze Age graves in Sion, CH/VS). Little bronze tubes and hangings suggest how the textile has been worn [55](Fig. 22).

A special item of clothing is the Late Bronze Age decorated sash from Cromagh in Ireland. It was found in a hoard together with a pin and an axe dating this find. It is woven of horse-hair in herringbone twill with 45/15 threads/cm. The sash is 5 cm wide[56].

In the Late Bronze Age lake-dwellings are more frequent in Central Europe again. But the layers are very often top layers, so they are not ideal for the preservation of organic material. Again tools related to textile production give more informations. On the Late Bronze Age site of Zug-Sumpf (CH/ZG) there are baskets (wicker-work), but no textiles. But a large quantity of spindle-whorls with weights between 10 g and 70 g show indirectly various qualities of threads. With spinning experiments we could calculate the final textile quality of about 20 threads/cm

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[52] Tidow 1992: 31-36.

[53] Zimmermann 1988: 26-38.

[54] Bazzanella et al. 2003: 161.

[55] Bocksberger 1978: Pl. 23-26.

[56] Heckett 1998: 29-37.

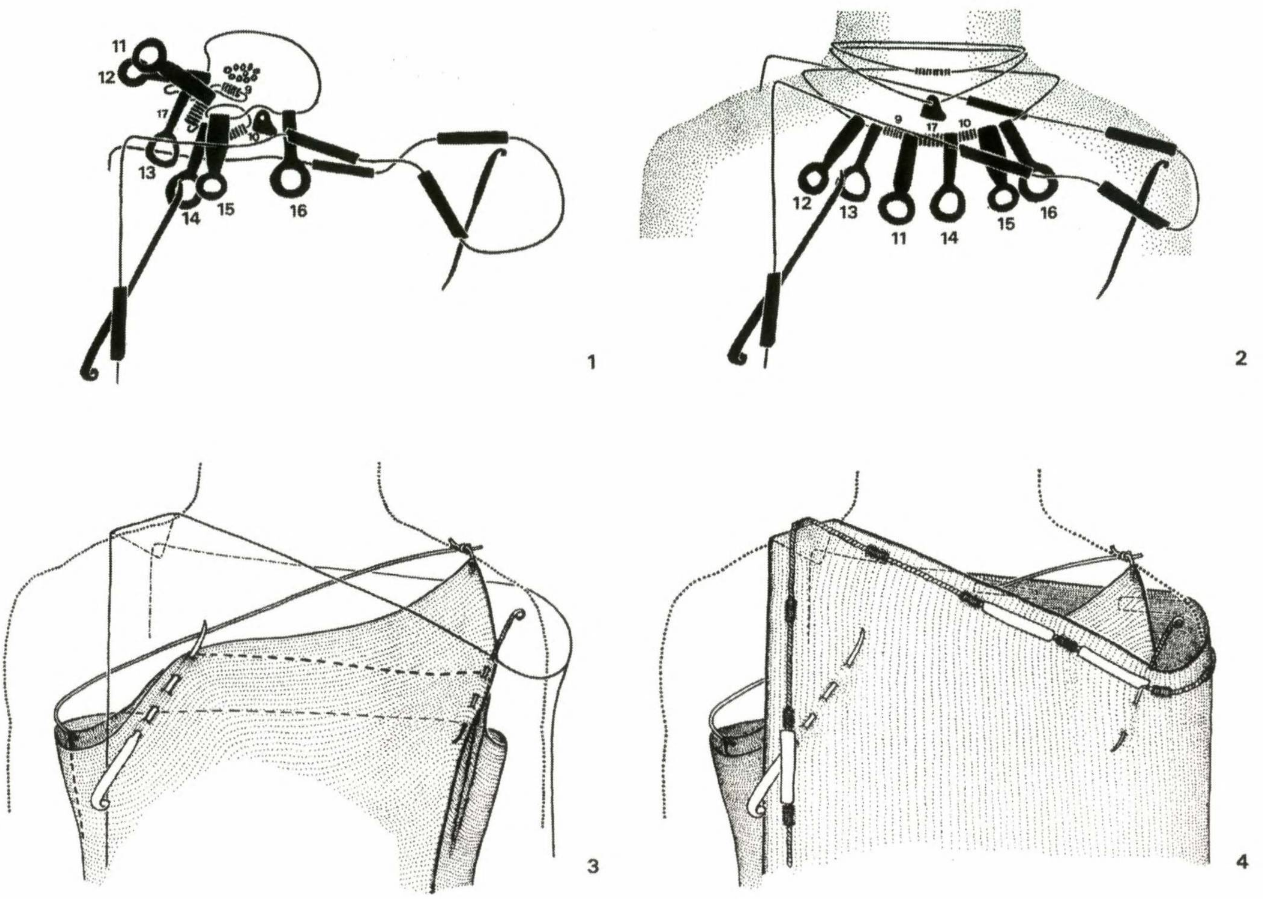

Fig. 22: Sion, Petit-Chasseur (CH/VS): Finds from grave 3 (1: in situ. – 2: correct placement of the metal objects) and reconstruction of the garment (3, 4). (based on Bocksberger 1978: Fig. 24).

(plied yarns) for the lightest spindle-whorls. Heavier whorls produce coarser threads which may have been used as single yarns[57].

Other objects related to textile production are little bobbins made of clay. M. Gleba has interpreted these „rocchetti“ from the Etruscan village of Poggio Civitate (I) as loom-weights in tablet-weaving[58]. They have also been found in the Early Iron Age graves of Verucchio (I), and the reconstruction proposed in this publication is based on this idea[59]. That means in fact, that the bobbins found in Late Bronze Age context e.g. in Switzerland (such as Zug-Sumpf) and so far interpreted as „bobbins“ are pointing to the beginning of tablet-weaving during the Bronze Age – a technique which was to become very important and elaborate in the Iron Age (Fig. 23)

Summary

The survey of the early development of textile crafts has shown that basketry started at latest in the Mesolithic period. These techniques were then still practiced in the Neolithic. Botanical remains of the 7th and 6th millennium BC place the start of flax cultivation a long time before the first Central European lake-dwellings. Large spindle whorls and loom-weights of the 6th millennium are best fitted for plant fibres – flax or tree-bast. Besides, impressions dated to the Linearbandkeramik-culture the first woven textiles appear in the lake-dwellings around 4.000 BC.

The Neolithic „bast-culture“ is replaced by a „wool-culture“ in the Bronze Age. The important change in textile technique seems to start at the end of the Neolithic and brings a change in tools, raw material, textile and dress types. Complete woollen garments from Northern Europe show the variety of wool weaving. By the beginning of the Iron Age the textile techniques used during that period were already settled, even tablet-weaving, which was probably the last achievement of the Bronze Age.

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[57] Rast-Eicher 2004: 268-275.

[58] Gleba 2000: 77-81.

[59] Ræder Knudsen 2002: 20-233, Fig. 104, 108.

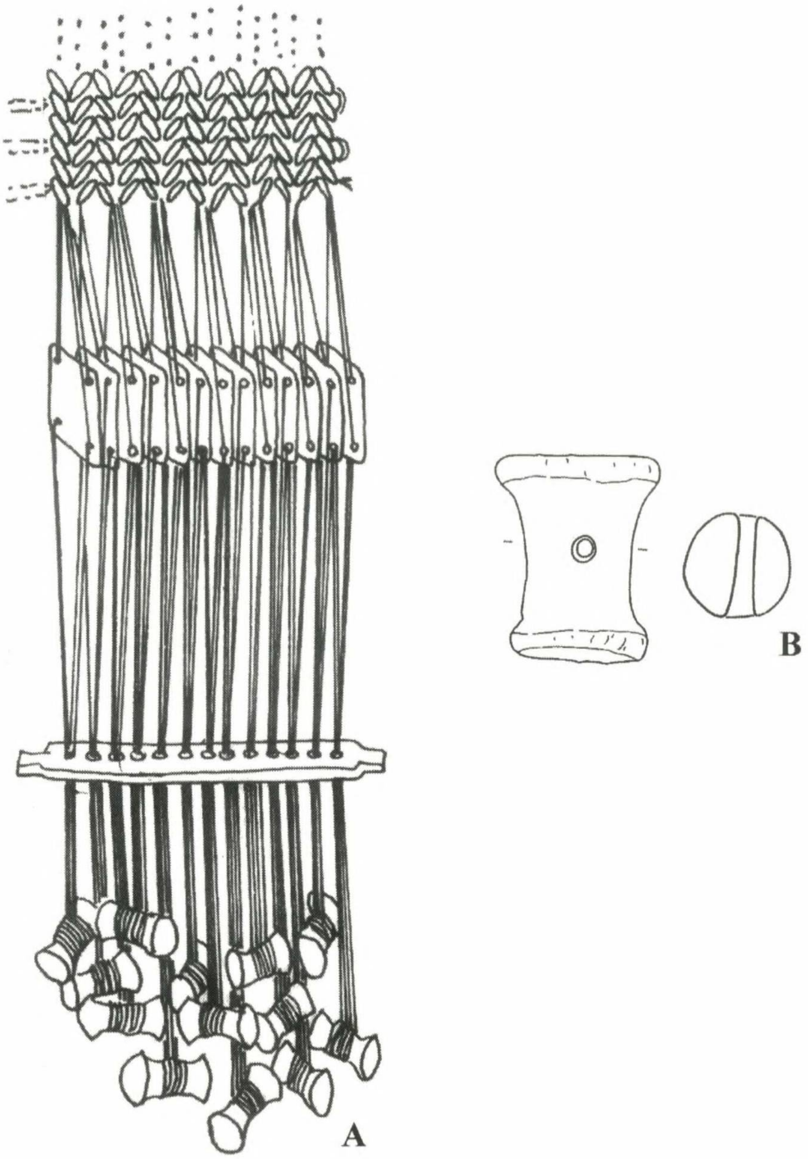

Fig. 23: Bobbins used as loom-weights for tablet weaving. A: Reconstruction after Raeder Knudsen. – B: Example of late Bronze Age bobbin, Zug-Sumpf (Pictures based on: A: Ræder Knudsen 2002: Fig. 104. – B: Bauer et al. 2004: pl. 207, no 2338).

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Curriculum vitae

Antoinette Rast-Eicher, lic.phil.I, is working as a freelance archaeologist and specializes in textiles. Neolithic and Bronze Age basketry and textiles are also part of her research, as are Iron Age and Early Medieval grave finds and Medieval textiles.

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Hallstatt and La Tène Textiles from the Archives of Central Europe

Lise Bender Jørgensen

Abstract

After a brief outline of the research history of Hallstatt and La Tène textiles, the main results are presented of the author's recordings in Central European museums in 1987. These are compared with the results of Hans-Jürgen Hundt, Katharina von Kurzynski and Johanna Banck-Burgess. The paper concludes with a discussion of how textile remains can be used to investigate modes of production, establishing function, and explore symbolical meanings.

Nach einer kurzen Skizze der Forschungsgeschichte hallstatt- und latènezeitlicher Textilien werden die wichtigsten Ergebnisse vom Materialaufnahme der Verfasserin aus dem Jahre 1987 in mitteleuropäischen Museen präsentiert. Durch den Vergleich mit den Resultaten von Hans-Jürgen Hundt, Katharina von Kurzynski und Johanna Banck-Burgess kann das Potential der Textilien für Aussagen über Produktionsformen, Funktionsbestimmung und Symbolik diskutiert werden.

An Outline of Research History

The study of Hallstatt and La Tène textiles was initiated in the late 1950's by Professor Hans-Jürgen Hundt (1909-1990) of the Römisch-Germanisches Museum in Mainz. His work soon caused archaeologists from all of Central Europe to send textile finds to Mainz for investigation, analysis and conservation. By 1980 he had published textiles from 15 graves of the Hallstatt Period and 24 of the La Tène Period, and a further 63 textiles from the saltmines in Hallstatt and Dürrnberg in Hallein[1]. Before his death in 1990, several further finds had been added to his portfolio, such as the textiles from the princely Hochdorf grave[2]. Hundt's textile publications are usually quite brief, although longer works exist. Regardless their length, his works always focus on meticulous description and documentation of the textiles examined, rather than indulge in generalisations and interpretations. Still, over the years he built up an extensive overall knowledge of Hallstatt and La Tène textiles, and had clear ideas that can be found as sparks of insights in his publications. His paper on the textiles from the Worms-Herrnsheim princely grave is a splendid example of this[3]. In addition to a detailed description of the textile remains from Worms-Herrnsheim, its three pages also contain a of summing-up of the development of textiles in Central Europe from the Neolithic to the Migration Period. Among the points made may be mentioned the preference for plied yarns throughout the Bronze Age and Hallstatt periods, and that 2/2 twill first appears in the Late Bronze Age (final Tumulus and Urnfield Cultures) but is not commonly used until the beginning of the Iron Age. Hundt further stated that 2/2 twills with plied warp and single weft yarns appear to be a standard fabric of the Hallstatt Period, although accompanied by other types such as twills made from single yarns, arranged in groups with different twist to create subtle spin patterns. With the advent of the La Tène Period plied yarns were replaced by single yarns. At the time of writing, Hundt did not know any examples of spin patterned fabrics from the La Tène and Roman Periods, but remarked that that they seemed to have returned to favour in the Migration Period.

While attempting to establish an overview of archaeological textiles in northern Europe, the present author entered the field of Hallstatt and La Tène textiles in the 1980's[4]. Establishing data to accomplish this was an essential part of my work. Textile remains may be preserved – or replaced – by metal salts. This made bronze and iron artefacts from inhumation graves an important hunting ground. At that time, such minor textile remains had generally remained unnoticed, but could be retrieved by being searched for systematically. It meant visiting museums all over northern Europe, rummaging through their stores. My work resulted in the construction of a textile typology – a chronological and geographical structure – presented in two books, one on Scandinavia (1986), the second covering the North European Lowlands and the British Isles (1992a). In 1987, I started recording finds in the central parts of Europe, visiting regional museums in Austria, Belgium, former Czechoslovakia, southern Germany, Hungary, Switzerland and parts of France. Only preliminary reports on the texti-

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[1] Hundt 1959, 1960, 1961, 1962, 1963, 1967, 1968, 1969, 1970, 1972, 1974a, b, c, 1975.

[2] Hundt 1981, 1983a, b, 1985, 1987.

[3] Hundt 1974c.

[4] Bender Jørgensen 1986, 1992a.

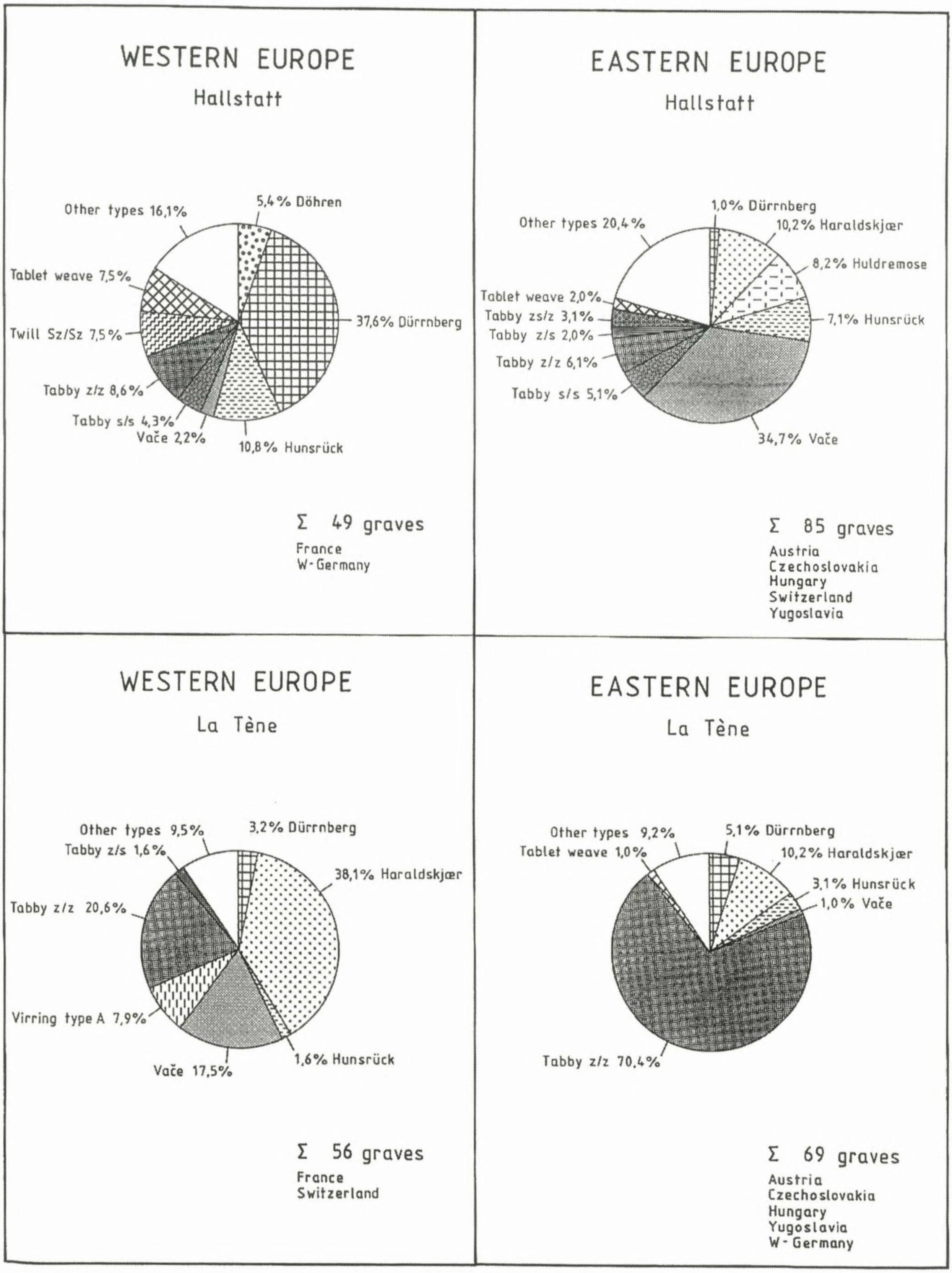
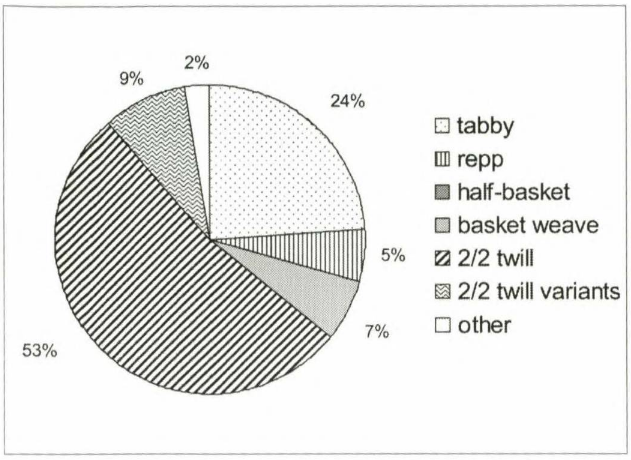


Fig. 1: Pie diagrams of Hallstatt and La Tène textiles in eastern and western Europe (after Bender Jørgensen 1992, drawing: Alice Lundgren).



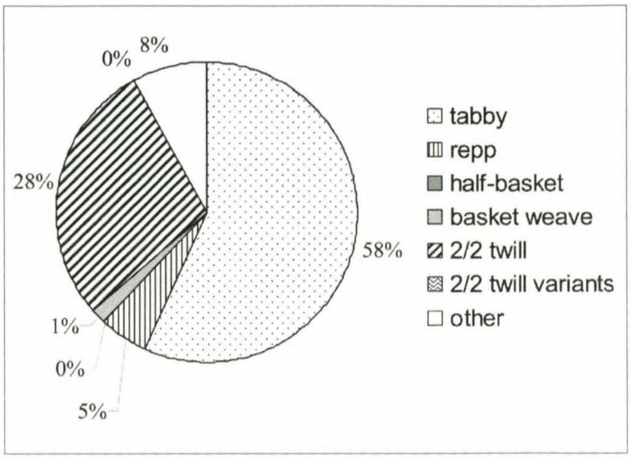
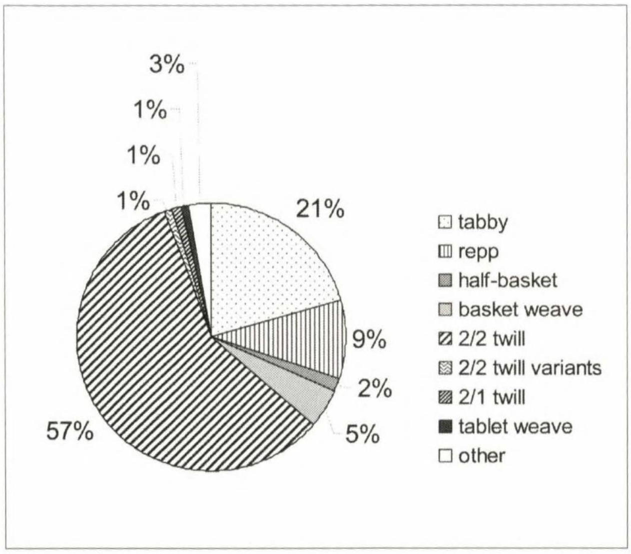


Fig. 2. (left) Pie diagram of weave types, Hallstatt C/D eastern group (after von Kurzynski 1996).
Fig. 3: (right) Pie diagram of weave types, Dürrnberg La Tène (after von Kurzynski 1996).



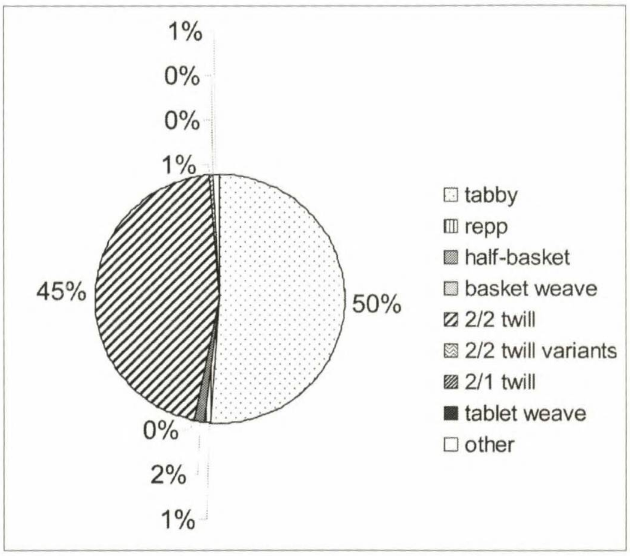


Fig. 4: (left) Pie diagram of Hallstatt weave types recorded 1987 (© L. Bender Jørgensen).
Fig. 5: (right) Pie diagram of La Tène weave types recorded 1987 (© L. Bender Jørgensen).

les catalogued have as yet been published[5]. The main outcome of those dealing with textiles of the Hallstatt and La Tène periods is a proposal for establishing three distinctive textile types: the Dürrnberg type (twills with plied warp and single weft), the Hunsrück type (tabbies with plied warp) and the Vače type (spin-patterned twills). Furthermore, textiles of the two periods are sorted into an eastern and a western group (Fig. 1).

In 1996, Katharina von Kurzynski catalogued 95 Hallstatt Period sites with textiles from Austria, France, Germany, Slovenia, Slovakia, Switzerland, and a further 69 La Tène finds from the same countries plus the Czech Republic, Great Britain, Hungary and Luxembourg[6]. Most of these had been published, or mentioned, in previous publications; some were investigated by von Kurzynski herself. This allowed her to conclude that the development of textile technology during the Hallstatt Period must be considered the most rapid in Europe's Prehistory. 2/2 twill replaced tabby as the main weave, accompanied by a multitude of new weaves such as half-basket and basket weave, various twill variants such as 2/1 twill, chevron twill, herringbone twill and various forms of diamond twill. Tablet-woven braids with complicated and colourful patterns have turned up in several princely graves, as well as embroideries and other forms of patterning. Fibres included wool, flax and hemp, and occasionally other fibres such as horse or badger hair. La Tène textiles are simpler; like Hans-Jürgen Hundt, von Kurzynski states that the spin-patterned twills of the Hallstatt period almost disappear with the advent of the La Tène, except for the striped version. Contrary to Hundt, however, von Kurzynski finds plied warps combined with single weft yarns in more than half of the La Tène textiles, at least from the Dürrnberg. Kurzynski did not find much of value in my works, and certainly did not approve of the textile types I had defi-

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[5] Bender Jørgensen 1991a, b, 1992b.

[6] von Kurzynski 1996.

Country	Museum	Finds
AT	Naturhistorisches Museum Wien	50
AT	Oberösterreichisches Landesmuseum Linz	1
AT	Salzburger Museum Carolino Augusteum	24
AT	Steiermärkisches Landesmuseum Joanneum Graz	1
CH	Schweizerisches Landesmuseum Zürich	56
CZ	Moravske Muzeum Brno	25
CZ	Nàrodnì Muzeum Praha	1
DE	Bayrisches Nationalmuseum München	11
DE	Mittelrheinisches Landesmuseum Mainz	4
DE	Rheinisches Landesmuseum Trier	10
FR	Musée du Châtillonnais Châtillon-sur-Seine	3
FR	Musée Historique Lorrain, Nancy	2
FR	Musée de Normandie, Caen	1
HU	Herman Otto Muzeum Miskolc	3
HU	Magyar Nemzeti Múzeum, Budapest	8
HU	Mora Ferenc Muzeum Szeged	3
SK	Archeologické ústav SAV Nitra	8
SK	Slovenské Národné Múzeum, Bratislava	1
Total		212

Table 1: Museums and number of Hallstatt and La Tène textile finds recorded 1987 (© L. Bender Jørgensen).

ned[7]. Instead she stuck to weaves when creating graphs to illustrate the fabrics she found in the eastern Hallstatt group and among the La Tène textiles from Dürrnberg (Figs. 2 and 3).

Date	Phase	Numbers
Hallstatt		46
Hallstatt	C	31
Hallstatt	D	14
Hallstatt/La Tène		10
La Tène		24
La Tène	A	15
La Tène	A/B	16
La Tène	B	32
La Tène	B/C	9
La Tène	C	11
La Tène	B/C/D	3
La Tène	D	2
Undated		3
Total		213

Table 2: Dating framework of Hallstatt and La Tène textiles recorded 1987 (© L. Bender Jørgensen).

Johanna Banck-Burgess was next in line. In her 1999 doctoral thesis, she lists 538 textile finds from 364 graves, deriving from 234 sites in Austria, Belgium, the Czech Republic and Slovakia, Germany, Luxemburg, the Netherlands, Silesia, Slovenia and Switzerland[8]. This gives her a solid foundation for discussing chronological and geographical differences. She finds that my four groups are too simplistic, and adds to them[9]. According to Banck-Burgess, the textiles can be divided into three phases, an early, comprising Hallstatt C, a middle one consisting of Hallstatt D and La Tène A, and a late phase, formed by La Tène B-D. Although only represented by ten finds, the early phase has a rich variety of weaves, generally of high quality. The middle phase has a high find frequency, and allows Banck-Burgess to distinguish three geographical groups with different textile traditions: Mid- and Southern Central Europe, Western Europe, and East Central Europe. Differences are found in the use of plied or single yarns, and the use of spin-patterns. Banck's late phase is sorted into two geographical groups, one covering the former Czechoslovakia, the second Southwest and West Central Europe.

Further important contributions have been made by Hubert Masurel, who performed in-depth analyses on the Hallstatt

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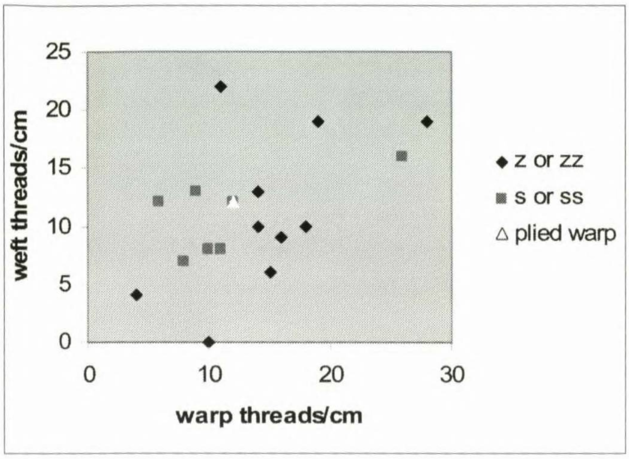
[7] von Kurzynski 1996: note 184.

[8] Banck-Burgess 1999.

[9] Banck-Burgess 1999: 45 ff).



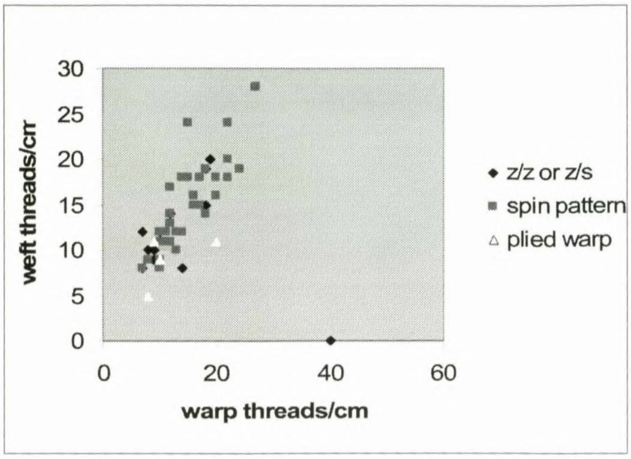
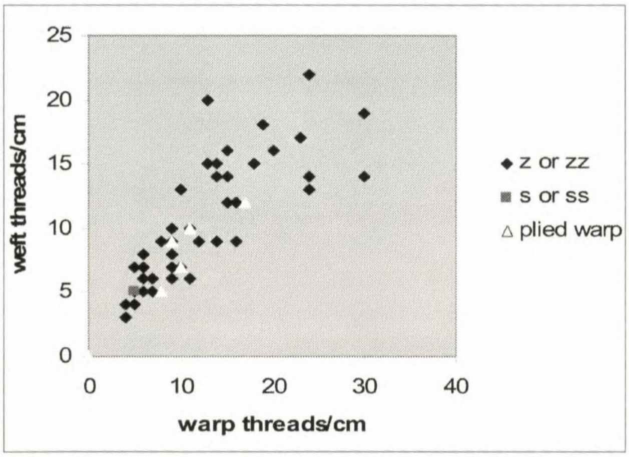


Fig. 6: (left) Scatter diagram of Hallstatt tabbies, half-basket and basket weaves recorded 1987 (© L. Bender Jørgensen).
Fig. 7: (right) Scatter diagram of Hallstatt twills recorded 1987 (© L. Bender Jørgensen).



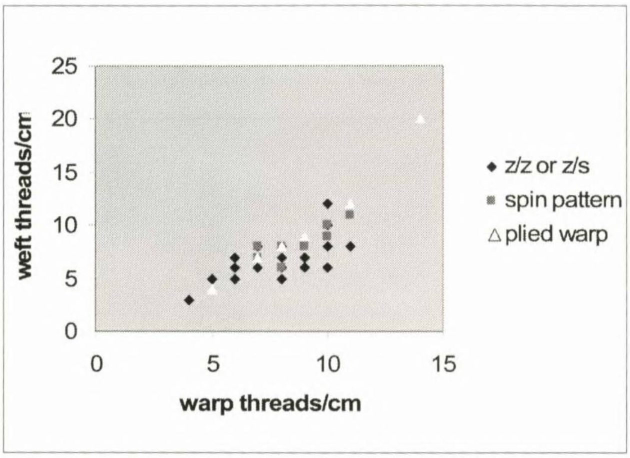


Fig. 8: (left) Scatter diagram of La Tène tabbies, half-basket and basket weaves recorded 1987 (© L. Bender Jørgensen).
Fig. 9: (right) Scatter diagram of La Tène twills recorded 1987 (© L. Bender Jørgensen).

period textiles from La Motte d'Apremont in France and their raw materials[10] and by Antoinette Rast-Eicher on the wool qualities of a number of La Tène textile finds from Switzerland, finding that early La Tène wools are coarser than those from the late La Tène[11]. Vaclav Furmánek and Karol Pieta catalogued Slovak textile finds[12].The extraordinary textile finds from the "Tomba del Trona" in the Villanovan cemetery of Verucchio in Italy add to our understanding of textile production and garment forms among the neighbours to the Hallstatt culture[13]. Recently, renewed investigations at both Hallstatt and the Dürrnberg in Hallein have recovered substantial numbers of textiles that have been studied by Katharina von Kurzynski[14].

Central Europe Revisited

The occasion of the 2004 symposium on Hallstatt textiles caused me to take a fresh look at my 1987 records of Central European textiles dating to the Hallstatt and La Tène periods, investigating how they fit into recent scholarship, and if they can still raise new questions and add to our knowledge. Visits to 17 museums and the Archaeology Department of the Slovak Academy of Science in Nitra resulted in the recording of 253 textile fragments from 212 different graves (Table 1). Few of these had been noticed before – comparisons with the catalogues of von Kurzynski and Banck-Burgess show a concurrence of only c. 20. This means that there are almost two hundred finds that may be added to the corpus of Hallstatt and La Tène textiles in Central Europe. 91 of the 212 finds may be dated to the Hallstatt period, 111 to the La Tène (Table 2). As regards Banck-Burgess's three-period system, 31 finds that can be attributed to her early phase, 28 to the middle, 57 to her late phase. Banck-Burgess' middle phase is the rich one, divisible into three geographical groups. As only a few new finds can be added, this paper will keep the older,

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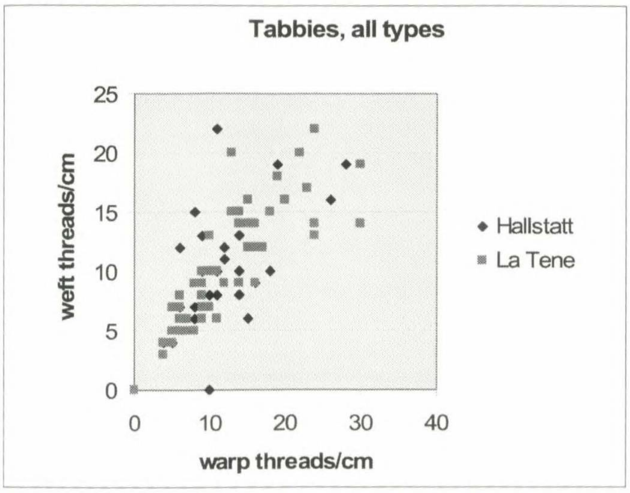
[10] Masurel 1988, 1990, 1992),

[11] Rast-Eicher 1998.

[12] Furmánek and Pieta 1985. – Pieta 1992.

[13] von Eles 2002.

[14] von Kurzynski 1998. – Stöllner et al. 2003).



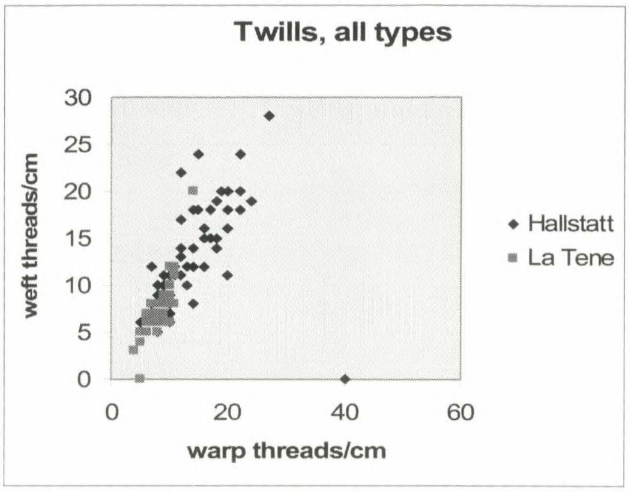


Fig. 10: (left) Scatter diagram of Hallstatt and La Tène tabbies, all yarn types, recorded 1987 (© L. Bender Jørgensen).
Fig. 11: (right) Scatter diagram of Hallstatt and La Tène twills, all yarn types, recorded 1987 (© L. Bender Jørgensen).

simplistic phasing of the Central European Iron Age, that of the Hallstatt and La Tène periods.

When the 1987 records are sorted into weaves (Figs. 4 and 5), we see that 2/2 twill is the most common form among the Hallstatt textiles. Tabbies are 21 %; repp and basket weave each make up a certain proportion. Half-basket, twill variants and others occur, but are rare. The La Tène diagram differs markedly; half of the textiles are now tabby. 2/2 twill is almost as dominant, while only 5 % are left for other weaves. What can we learn from that? What I find most conspicuous is the similarity to Katharina von Kurzynski's diagrams of weaves from the eastern Hallstatt area and the La Tène of Dürrnberg, particularly for the Hallstatt period. The 1987 records have an eastern emphasis. The majority derive from Austria, the Czech Republic, Slovakia, Hungary and Slovenia. Swiss finds are frequent too, but mainly date to the La Tène period. Finds from western Europe are comparatively few. It makes sense that the weaves of the "new" Hallstatt textiles compare well with Kurzynski's results.

When sorted into groups according to their yarns, we find that fabrics with plied warp are few among Hallstatt period finds (Figs. 6 and 7). This matches the few finds from western Europe. As mentioned above, a preference for plied yarns in the western parts of the Hallstatt area was recognised both by Banck-Burgess and myself. Among fabrics made from single yarns, tabbies, half-basket and basket weaves are based on either z- or s-spun yarns. The latter seem generally slightly coarser than the former, but not exclusively. Among the twills, spin-patterned fabrics show a wider range of qualities compared to the two other groups; those with plied warp are all relatively coarse. The La Tène fabrics show a different picture (Figs. 8 and 9). Tabbies, half-basket and basket weaves present a wide range of varieties, particularly among those made from single yarns. La Tène twills are quite coarse, 12 threads per cm being the finest count except for a single piece of 14/20. This has plied warp. No clear difference is apparent between spin-patterned twills and others. If we compare tabbies of all types of Hallstatt date with those of the La Tène period (Fig. 10) we get a relatively uniform pattern; when comparing the twills it becomes obvious that La Tène twills are much coarser than Hallstatt ones (Fig. 11).

What may we learn from this?

What can this investigation into my 1987 textile records add to our knowledge? For the eastern group of Hallstatt textiles, the distribution of weaves established by Katharina von Kurzynski seems to be confirmed; as for the west and mid-south, and the three phases proposed by Johanna Banck-Burgess, more data are now available but much more work is needed to extract possible additional information, variations or confirmation. We are still in the process of constructing a chronology and typology of Hallstatt and La Tène textiles, but it seems as if most of the main structure is in place; what is left is a matter of adjustment and refinement.

What else may we learn? Chronology and typology are the means to an end, not the sole objectives of research. What do the chronological changes and regional variations reflect? Why are La Tène twills coarser than those from the Hallstatt period? Why did people in the west prefer plied yarns for their warps, while those in the east mostly used single yarns? We are used to interpreting such changes in evolutionary terms, and tend to feel awkward about changes such as that from fine twills of Hallstatt date to coarse ones from the later La Tène period, and from a wider range of weaves to a more limited one. Did the textile technology go backwards? Or should explanations be sought elsewhere?

In 1992, I argued that the Vače and Dürrnberg types – twills with spin-pattern or a combination of plied warp and single yarns respectively – marked the beginnings of organised textile production in Europe. This was built on the assumption that such easily recognisable fabric forms could only exist if deriving from a standardized production[15]. Recent research has opened further possibilities. Preliminary reports on the recent textile finds from Dürrnberg interpret changes between the Hallstatt and La Tène period textiles as the development from complicated, domestic-style fabrics to a much more standardized production[16]. Further, in her analysis and interpretation of the textiles from the Tomba del Trono from Verucchio, Annemarie Stauffer argues that the two mantles – identifies as *tebennae* – were woven on a tall, narrow loom, and their tablet-woven borders added at a later stage. Although complicated and time-consuming, this would make it possible for a single person to perform the whole work process, and Stauffer proposes that certain aspects of textile production – such as the weaving of ceremonial garments like the *tebenna* – were the privilege of aristocratic women[17]. The Verucchio *tebennae*, and an unidentified garment from the same grave are all spin-patterned twills, i.e. examples of what I have termed the Vače type. If garment and fabric type were linked, the idea of form that caused standardization might be embedded in that of garment rather than that of production[18]. Was the textile production in the Hallstatt Period then controlled by women of the nobility, and the complicated production process both a reason for and symbol of their privilege? Were the menial tasks of spinning and weaving transferred to servants and slaves by the La Tène period? Possibly; but simpler explanations have been put forward too, e.g. by Johanna Banck-Burgess who interprets the change from twills to tabbies in the La Tène in Czechoslovakia in terms of the introduction of linen shrouds to clothe the dead[19].

Other pertinent questions are those of the function of the various textiles, and their meaning. Most textiles found in graves are small scraps encrusted on metal artefacts such as dress accessories or weapons. They supposedly derive from the dress or shrouding of the deceased. Clothing of the Hallstatt and La Tène periods is an almost virgin research field. Katharina von Kurzynski has gathered examples of iconographical evidence that shows a rich variety of garment forms, richly decorated and patterned[20]. They form an important background for trying to understand the Iron Age costume of Central Europe. The Verucchio garments, and the various items of clothing found in the acid bogs of northern Europe help too, although they belong to different cultural groups. Still, there is a huge leap from these evocative examples to the majority of textile finds – tiny metal-replaced scraps. There is much work to do, and we shall need some larger pieces with structural details to be able to start reconstructing garments. Textile properties is another theme that has hardly been addressed. When sorting textile fragments into weaves, yarns and fibres it is easy to forget that the *combination* of these features does in fact promote specific properties. Textiles may be warm, cool, absorbent or water repellent, all according to their construction; insights into how these properties are established may help us to distinguish between textile categories and identify likely functions. Rich finds like the princely grave from Hochdorf remind us that textiles are used for other things than clothing: wall hangings, carpets, bedding and household textiles like towels[21]. The study of ancient textiles is a Pandora's box just waiting to be opened.

Hallstatt- und latènezeitliche Textilien aus Museumsarchiven in Zentraleuropa

Etwa im Jahre 1960 begann Prof. Dr. Hans-Jürgen Hundt (Römisch-Germanisches Zentralmuseum in Mainz), hallstatt- und latènezeitliche Textilfunde aus ganz Mitteleuropa zu studieren und publizieren. Meist geschah dies in ganz kurzer Form, wobei die genaue Beschreibung und Dokumentation der Hauptziel war. Über die Jahre hinweg baute er eine solide Kenntnis auf, die als kurze aber weitreichende Zusammenfassungen der bronze- und eisenzeitlichen Textilgeschichte Europas in seine Artikeln auftaucht[22]. Hundt's Beobachtungen erfassen etwa die Vorliebe von Zwirnen der Bronze- und Hallstattzeit; die Einführung von Köper 2/2 am Ende der Bronzezeit, sowie die Erkenntnis, dass Köper 2/2 mit Kette aus Zwirn und einfachem Garne als Schuss während der Hallstattzeit gängig war, aber am Anfang der Latènezeit von Geweben aus einfacheren Garnen ersetzt wurde. Die Verfasserin hat in den 1980er Jahren die Arbeit von Hundt fortgesetzt und hat 1991-1992 drei hallstatt/latènezeitliche Gewebetypen definiert und die Einteilung in eine Ost- und eine Westgruppe vorgeschlagen[23] (Fig. 1). Katharina von Kurzynski (1996) und Johanna Banck-Burgess (1999) haben diese chronologische und geographische Struktur weiter abgestuft (Fig. 2-3).

1987 wurde von der Verfasserin eine umfassende Fundaufnahme vor- und frühgeschichtlicher Textilien in Mitteleuropa durchgeführt. 253 davon sind hallstatt- oder latènezeitlich, und stammen aus 212 Gräbern oder Fundplätzen (Tabelle 1 und 2). Nur etwa 20 von diesen waren bereits

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[15] Bender Jørgensen 1992: 122 ff.

[16] Stöllner 2003: 180.

[17] Stauffer in von Eles 2002: 207 ff.

[18] The Verucchio *tebennae* would have appeared subtly patterned, in shimmering checks according to how the light fell. We find the same check pattern in the oval wool mantle from Gerumsberget in Sweden (von Post et al. 1925). Folded, the form of this garment would have resembled the *tebenna*; its checks are created by colour rather than spin pattern, but when seen from a distance, the appearance would have been quite similar. Is this accidental or intentional? The theme of oval and semicircular mantles and their decoration could be worth investigating. The Gerumsberg mantle has been carbon-14 dated to c. 300 BC. – Nockert and Possnert 2002.

[19] Banck-Burgess 1999: 47.

[20] von Kurzynski 1996: 44 ff.

[21] Banck-Burgess 1999: Abb. 4 and Beilage 2.

[22] Z. B: Hundt 1974c.

[23] Bender Jørgensen 1991a, 1992a,b.

bei von Kurzynski oder Banck-Burgess katalogisiert. Das neue Material läßt sich nicht gut mit der detaillierten chronologischen und geographischen Struktur von Banck-Burgess korrelieren, aber zeigt gute Korrespondenz mit den Resultaten von Katharina v. Kurzynski. Dies gilt sowohl bei der Verteilung von Gewebetypen (Fig. 4-5), als auch bei den Kombinationsanalysen von Garn- und Gewebetypen (Fig. 6-11). Die hallstattzeitlichen Textilien zeigen eine grössere Variationsbreite als die latènezeitlichen, sowohl was die Auswahl von Gewebetypen als auch die Feinheiten betrifft. Die latènezeitlichen Köpergewebe 2/2 sind markant gröber als die der Hallstattzeit.

Wie können wir die chronologische und typologische Struktur hallstatt- und latènezeitlicher Textilen deuten? Wie war die Textilproduktion organisiert? Verschiedene Vorschläge liegen dazu schon vor. Die Verfasserin sah 1992 die charakteristischen Gewebetypen der Hallstattzeit als Argumenten für eine organisierte Textilproduktion[24]; die engere, mehr einheitliche Auswahl von latènezeitlichen Gewebe sah auch Thomas Stöllner[25] als Beleg für eine Entwicklung von individuellen, hausgemachten Textilien an eine standardisierte Produktion. Die Untersuchungen von zwei Mänteln der villanovazeitlichen Tomba del Trono in Verucchio zeigen eine sehr komplizierte Produktionsweise, was Annemarie Stauffer zu einer Interpretation veranlasste, bei der sie die Produktion solcher Mäntel als ein Privilegium vornehmer Frauen sieht[26]. Johanna Banck-Burgess hat eine einfachere Auslegung vorgeschlagen: die Abänderung vom hallstattzeitlichen Köpergewebe zur latènezeitlichen Leinwand in Tschechien und in der Slowakei wird von der Einführung von Leichentüchern verursacht.

Die Frage der Produktionsform ist nur eine unter vielen neuen Perspektiven, die uns die wachsende Menge von hallstatt- und latènezeitlichen Textilfunden eröffnen. Auch Fragen über die Bedeutung, Funktion und Eigenschaften gehören dazu. Wie die Schachtel der Pandora fasst auch die Textilforschung reiche Möglichkeiten.

Catalogue of Hallstatt and La Tène Textiles

Czech Republic

1: Unknown, Národní Muzeum Praha Description of find: Iron sword, mount with textile remains. Weave: 2/2 twill, spin warp: S2z, spin weft: z, warp count 7, weft count 7, fibre -, Date La Tène Phase - , Date of record 1987-03-03

2: Brno-Zidenice, Moravia. Moravske Muzeum. Description of find: Bronze mail with textile remains on back. Weave: half basket, spin warp: z, spin weft: zz, warp count: 12, weft count: 11, fibre: - Date: Hallstatt, Phase: -, Date of record 1987-03-12

3: Stare Měste, Moravia. Moravske Muzeum, 108.603, Pa 36/73. Description of find: Pottery fragment with textile remains. Weave: tabby? spin warp: S2z,z, spin weft: S2z, warp count: 20, weft count: 20, fibre: -, Date: Lausitz/Velatice, Date of record: 1987-03-12.

4: Blučina, Brno-Venkov, Moravia. Moravske Muzeum, grave 11. Description of find: Iron sword w sheath and textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 9, weft count: 6, fibre: wool, Date La Tène B, Date of record: 1987-03-12

5: Blučina, Brno-Venkov, Moravia. Moravske Muzeum, 55-56/63 grave 13. Description of find: Iron fragment with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 7, weft count: 5, Date: La Tène C, Date of record: 1987-03-12.

6: Blučina, Brno-Venkov, Moravia. Moravske Muzeum, 69/63, grave 16. Description of find: Lance with textile fragment. Weave: 2/2 twill, spin warp: S2z, spin weft: z, warp count: 8, weft count: 8, Date: La Tène C/D, Date of record: 1987-03-12

7: Brno-Maloměřice, Brno-Město, Moravia. Moravske Muzeum, 107.558, Pa 14.418, grave 48. Description of find: Hollow bronze ring filled with fabric. Weave: tabby, spin warp: z, spin weft: z, warp count: 11, weft count: 6, fibre: flax, Date: La Tene, Date of record: 1987-03-12.

8: Brno-Maloměřice, Brno-Město, Moravia. Moravske Muzeum, 111.014, grave 67. Description of find: Hollow bronze ring filled with textile. Weave: tabby, spin warp: z, spin weft: z, warp count: 14, weft count: 15, fibre: flax, Date: La Tène B/C, Date of record: 1987-03-12

9: Brno-Maloměřice, Brno-Město, Moravia. Moravske Muzeum. Description of find: Iron fragment with textile. Weave: tabby, spin warp: z, spin weft: z, warp count: 5, weft count: 4, fibre: wool, Date: La Tène B, Date of record: 1987-03-12.

10: Bučovice, Vyškov, Moravia. Moravske Muzeum, Pa 31/35-192, grave 14. Description of find: Bronze rings with iron and textile. Weave: tabby, spin warp: z, spin weft: z, warp count: 15, weft count: 14, fibre: flax?, Date: La Tène B, Date of record: 1987-03-12.

11: Bučovice, Vyškov, Moravia. Moravske Muzeum 111.422, grave 20. Description of find: Bronze fibula with textile. Weave: - Spin warp: z, spin weft: z, warp count: -, weft count: - . Frag.2, Moravske Muzeum, 111.417 grave 20. Description of find: Bronze ring with impressions of textile remains. Weave: tabby?, spin warp: z, spin weft: z, warp count: 6, weft count: 8. Date: La Tène B, Date of record: 1987-03-12.

12: Holubice, Vyškov, Moravia. Moravske Muzeum 111.127, grave 8. Description of find: Iron ring with replaced textile fragment. Weave: tabby, spin warp: z, spin weft: z, warp count: 9, weft count: 7, fibre: wool, Date: La Tène B/C, Date of record: 1987-03-12.

13, Site Holubice, Vyškov, Moravia. Moravske Muzeum 111.273, grave 21. Description of find: chain fragments, iron and bronze, with several textiles fragments. Weave: tabby, spin warp: z, spin weft: z, warp count: 9, weft count: 8, fibre: wool?, Date: La Tène C, Date of record: 1987-03-12.

14: Holubice, Vyškov, Moravia. Moravske Muzeum 111.311, grave 35. Description of find: iron fragment from sword with textile remains. Weave: half-basket, spin warp: z, spin weft: zz, warp count: 10, weft count: 13. Frag. 2: Moravske Muzeum 111.307. Description of find: iron fragment (sword, knife) with mineralised textile. Weave: tabby, spin warp: z, spin weft: z, warp count: 4, weft count: 4, fibre: wool?, Date: La Tène B, Date of record: 1987-03-12.

15: Holubice, Vyškov, Moravia. Moravske Muzeum 111.182, grave 50. Description of find: fragment of sword scabbard with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 5, weft count: 4, fibre: wool?, Date: La Tène B, Date of record: 1987-03-12.

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[24] Bender Jørgensen 1992a: 122 ff.

[25] Stöllner et al. 2003: 180.

[26] Stauffer 2002: 207 ff.

16: Holubice, Vyškov, Moravia. Moravske Muzeum 111.204, grave 56. Description of find: iron fibula mineralised textile fragments, several layers. Weave: tabby, spin warp: z, spin weft: z, warp count: 18, weft count: 15, fibre: flax?. Frag. 2: Moravske Muzeum 111.204. Description of find: iron fibula mineralised textiles in several layers. Weave: twill, spin warp: z, spin weft: z, warp count: 8, weft count: 8, fibre: wool?, Date: La Tène C, Date of record: 1987-03-12

17: Holubice, Vyškov, Moravia. Moravske Muzeum 64.872. Description of find: chain fragments, iron and bronze, with several textile fragments. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 8, weft count: 7, Date: La Tène B, Date of record: 1987-03-12.

18: Křenovice u Slarkova, Vyškov, Moravia. Moravske Muzeum 111.059, Pa 1295/38, grave 12. Description of find: iron fibula with impression of textile on back. Weave: tabby, spin warp: z, spin weft: z, warp count: 6, weft count: 5, fibre: wool?, Date: La Tène B, Date of record 1987-03-12.

19: Křenovice u Slarkova, Vyškov, Moravia. Moravske Muzeum 111.069, Pa 1316/38, grave 17. Description of find: fragments of bronze arm ring covered by textile. Weave: tabby, spin warp: z, spin weft: z, warp count: 9, weft count: 9, fibre: flax, Date: La Tène B, Date of record: 1987-03-12.

20: Postoupky, Kroměříz, Moravia. Moravske Muzeum 65.237. Description of find: fragments of iron sword with mineralised textile. Weave: tabby, spin warp: s, spin weft: s, warp count: 5, weft count: 5, fibre: wool, Date: La Tène, Date of record: 1987-03-12.

21: Slavkov, Vyškov, Moravia. Moravske Muzeum 64.898-99. Description of find: Iron button with mineralised textile fragment. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 8, weft count: 8, Date: La Tène B, Date of record: 1987-03-12.

22: Slavkov, Vyškov, Moravia. Moravske Muzeum 70.450. Description of find: Iron fragment with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 14, weft count: 15, fibre: flax?, Date: La Tène, Date of record: 1987-03-12.

23: St. Břeclav, Břeclav, Moravia. Moravske Muzeum 65.097. Description of find: Iron shears? with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 5, weft count: 4, fibre: wool?, Date: La Tène, Date of record: 1987-03-12.

24: Telnice, Brno-Venkov, Moravia. Moravske Muzeum 66.162. Description of find: iron fragment with textile fragment. Weave: tabby, spin warp: z, spin weft: z, warp count: 14, weft count: 14, Date: La Tène, Date of record: 1987-03-12.

25: Židenice, Moravia. Moravske Muzeum 65.085, 65081-92. Description of find: Iron fragment with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 12, weft count 9, fibre: wool? Frag. 2: Moravske Muzeum 65.084, 86-87, 65081-92. Description of find: Iron fragment with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 12, weft count: 9, Date: La Tène, Date of record: 1987-03-12.

26: Site unknown, Moravia. Moravske Muzeum 432. Description of find: iron fragments with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 10, weft count: 7, fibre: wool?, Frag. 2: Moravske Muzeum 432. Description of find: iron fragments with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 15, weft count: 16, fibre: flax?, Date: La Tène, Date of record: 1987-03-12.

Slovakia

27: Molpír, Smolenice, Trnava. Slovensku Akademie Vlad P c 46. Description of find: lump of strings. Yarn, Z2s, fibre: wool. Date: Hallstatt D, Date of record: 1987-03-19.

28: Bučany, Kopanice, Trnava. Slovensku Akademie Vlad grave 7. Description of find: iron knife with textile fragments. Weave: half-basket, spin warp: z, spin weft: zz, warp count: 11, weft count: 22, Date: Hallstatt D, Date of record: 1987-03-18.

29: Dolný Peter, Komárno, Slovensku Akademie Vlad grave 55. Description of find: hollow bronze ring filled with textile. Weave: tabby, spin warp: z, spin weft: z, warp count: 14, weft count: 14, fibre: flax?, Date: La Tène, Date of record: 1987-03-18.

30: Dolný Peter, Komárno, Slovensku Akademie Vlad, grave 58. Description of find: Textile fragments. Weave: tabby, spin warp: z, spin weft: z, warp count: 24, weft count: 14, fibre: flax, Date: La Tène, Date of record: 1987-03-18.

31: Hurbanovo, Komárno, Slovensku Akademie Vlad Pc 39, grave 1/80. Description of find: Bronze ring with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 24, weft count: 22, Date: La Tène, Date of record: 1987-03-19.

32: Nitra. Slovensku Akademie Vlad Pc 5. Description of find: Textile fragment from arm ring. Weave: tabby, spin warp: z, spin weft: z, warp count: 16, weft count: 9, Date: La Tène. Date of record: 1987-03-19.

33: Nové Zámky, Nové Zámky. Slovensku Akademie Vlad grave 9/70. Frag. 1: c 2. Description of find: Textile fragment, Weave: tabby, spin warp: z, spin weft: z, warp count: 24, weft count: 13, fibre: flax. Frag. 2: c 5. Description of find: Textile fragment, Weave: tabby, spin warp: z, spin weft: z, warp count: 20, weft count: 16, fibre: flax. Frag. 3: c 3. Description of find: Textile fragment from hollow bronze ring. Weave: tabby, spin warp: z, spin weft: z, warp count: 30, weft count: 14, fibre: flax. Frag. 4: grave 9/70? Description of find: Textile fragment, Weave: tabby, spin warp: z, spin weft: z, warp count: 30, weft count: 19, fibre: flax. Frag. 5: c 4. Description of find: Textile from hollow arm ring. Weave: tabby, spin warp: z, spin weft: z, warp count: 24, weft count: 13, fibre: flax, Date: La Tène A/B, Date of record: 1987-03-18.

34: Trnovec, Galanta. Slovensku Akademie Vlad grave 362. Description of find: Iron sword with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 4, weft count: 3, fibre: wool?, Date: La Tène, Date of record: 1987-03-19.

35: Vělká Maňa, Vráble. Slovenska Narodne Muzeum c 7138. Description of find: Lance with textile impressions. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 8, weft count: 7, Date - Date of record: 1987-03-16.

Hungary

36: Jánoshásza, Magyar Nemzeti Muzeum 43/1949:6. Description of find: Half of iron ring buckle with textile fragments. Weave: 2/2 twill, spin warp: z,s, spin weft: z,s, warp count: 14, weft count: -, fibre: 20, Date: Urnfield? Date of record: 1987-03-25.

37: Kismezö, Magyar Nemzeti Muzeum 46/1949:20, tumulus. Description of find: Iron ring fragment with textile remains. Weave: half-basket, spin warp: z, spin weft: zz, warp count: 12, weft count: 14, Date: Hallstatt/La Tène, Date of record: 1987-03-25.

38: Kosd, Nógrád, Magyar Nemzeti Muzeum 46/1951:289, k 29. Description of find: Sickle-shaped razor with textile fragment. Weave: tabby, spin warp: z, spin weft: z, warp count: 6, weft count: 6, fibre: wool?, Date: La Tène, Date of record: 1987-03-25.

39: Kosd, Nógrád, Magyar Nemzeti Muzeum 46/1951:625, grave 43, fragment. 1: Description of find: Iron knife wrapped in textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 5, weft count: 5, fibre: wool. Fragment 2. Description of find: back side of above. Weave: tabby, spin warp: z, spin weft: z, warp count: 9, weft count: 6, fibre: wool. Date: La Tène, Date of record: 1987-03-25

40: Kosd, Nógrád, Magyar Nemzeti Muzeum 46/651:666 k 66. Description of find: La Tènefibula with textile fragment. Weave: tabby, spin warp: z, spin weft: z, warp count: 23, weft count: 17, fibre: flax?, Date: La Tène C, Date of record: 1987-03-25.

41: Kosd, Nógrád, Magyar Nemzeti Muzeum 46/1951:520, grave 54. Description of find: Iron knife with textile remains.

Weave: tabby, spin warp: -, spin weft: -, warp count: 22, weft count: 20, Date: La Tène B, Date of record: 1987-03-25.

42: Kosd, Nógrád, Magyar Nemzeti Muzeum 46/1951:571. Description of find: bronze ring with textile fragment. Weave: tabby, spin warp: z, spin weft: z, warp count: 16, weft count: 12, Date: La Tène, Date of record: 1987-03-25.

43: Szentes-Vekerzúg, Csongrád, Magyar Nemzeti Muzeum 53/51:216. Description of find: Bronze disc with textile impressions on back. Weave: half-basket, spin warp: z, spin weft: zz, warp count: 13, weft count: 20, Date: La Tène D1, Date of record: 1987-03-25.

44: Bodroghalom, Borsod-Abaúj-Zamplen, Herman Otto Muzeum Miskolc 83.18.24, 1977 grave 20. Description of find: Iron fragments with textile remains. Weave: twill?, spin warp: z, spin weft: s, z?, warp count: 10, weft count: 12, Date: La Tène C, Date of record: 1987-03-31.

45: Bodroghalom, Borsod-Abaúj-Zamplén, Herman Otto Muzeum Miskolc 83.18.55. Description of find: Piece of felt. Fibre: wool. Date: La Tène C? Date of record: 1987-03-31.

46: Bodroghalom, Borsod-Abaúj-Zamplen, Herman Otto Muzeum Miskolc 83.18.107, 3.vas kés grave 10. Description of find: Iron knife with textile fragment. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 4, weft count: 3, Date: La Tène C? Date of record: 1987-03-31.

47: Csanylelek, Ujhalasto, Mora Ferenc Muzeum Szeged 83.1.84, 1979 nr 26, 15 milt?, grave 16. Description of find: Iron ring with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 28, weft count: 19, Date: Hallstatt, Date of record: 1987-04-02.

48: Csanylelek, Ujhalasto, Mora Ferenc Muzeum Szeged 83.1.207, grave 44. Description of find: Iron ring with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 16, weft count: 8, Date: Hallstatt/La Tène. Date of record: 1987-04-03.

49: Sándorfalva, Eperjes, Mora Ferenc Muzeum Szeged 84.2.70, grave 138. Description of find: Iron ring with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 15, weft count: 6, fibre: wool? Date: Hallstatt D, Date of record: 1987-04-02.

Austria

50: Mattsee, Buchberg, Salzburg-Land. Salzburger Museum Carolino Augusteum 222/48. Description of find: Iron object partly covered by textile remains. Weave: basket weave, spin warp: zz, spin weft: zz, warp count: 8, weft count: 15, Date: Hallstatt C, Date of record: 1987-08-18.

51: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum 6/75 grave 6. Description of find: Iron knife with encrusted textile remains. Weave: 2/2 twill, spin warp: z,s, spin weft: z,s, warp count: 18, weft count: 14, Date: Hallstatt C, Date of record: 1987-08-18.

52: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum 2/76 grave 15. Description of find: Iron fragment with encrusted textile remains, badly preserved. Weave: 2/2 twill, spin warp: -, spin weft: -, warp count: 14, weft count: 14, Date: Hallstatt C, Date of record: 1987-08-18.

53: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum QU 15, 13/76 grave 19. Description of find: Iron knife with encrusted textile remains. Weave: 2/2 twill, spin warp: 8z, 8s, spin weft: z,s, warp count: 22, weft count: 18, Date: Hallstatt C, Date of record: 1987-08-18.

54: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum QU 30, 38/76 grave 26. Description of find: Iron knife with impression of textile. Weave. 2/2 twill, spin warp: z,s, spin weft: z,s, warp count: 14, weft count: 18, Date: Hallstatt C, Date of record: 1987-08-18.

55: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum QU 43, 86/77 grave 56. Description of find: Iron knife with textile remains. Weave: basket weave, spin warp: ss,zz, spin weft: zz, warp count: 10, weft count: 8, Date: Hallstatt C, Date of record: 1987-08-18.

56: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum QU 68, 141/78 grave 102. Description of find: Mehrkopfnadel with textile remains. Weave: 2/2 twill, spin warp: z,s, spin weft: z,s, warp count: 12, weft count: 13, Date: Hallstatt C, Date of record: 1987-08-18.

57: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum QU 52, 181/77 grave 79. Description of find: Iron knife with incrusted textile remains and loose fragments. Weave: tabby, spin warp: s, spin weft: s, warp count: 9, weft count: 13, Date: Hallstatt C, Date of record: 1987-08-18.

58: Uttendorf im Pinzgau, Salzburg-Land. Salzburg Museum, 170/77 grave 76. Description of find: Iron knife with textile remains. Weave: tabby, spin warp: z,s, spin weft: z,s, warp count: 9, weft count: 10, Date: Hallstatt C, Date of record: 1987-08-18.

59: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum 201/77 grave 83. Description of find: Iron knife with encrusted textile remains. Weave: 2/2 twill, spin warp: 8z,8s, spin weft: 8z,8s, warp count: 11, weft count: 12, Date: Hallstatt C, Date of record: 1987-08-18.

60: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum QU 41, 231/77 grave 88. Description of find: Iron pin with encrusted textile remains and loose fragment. Weave: tabby, spin warp: z,s, spin weft: z, warp count: 10, weft count: 8, Date: Hallstatt C, Date of record: 1987-08-18.

61: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum QU 76, 192/78 grave 116, frag. 1. Description of find: Bronze and iron fragments with encrusted textile remains. Weave: basket weave, spin warp: ss, spin weft: ss, warp count: 5, weft count: 4. Frag. 2: Description of find: Weave 2/2 twill, spin warp: z, spin weft: z, warp count: 9, weft count: 9. Frag. 3: Description of find: Weave: 2/2 twill, spin warp: z,s, spin weft: z,s, warp count: 10, weft count: 12. Frag. 4: 191/78. Description of find: Iron knife with encrusted textile remains. Weave: 2/2 twill, spin warp: s, spin weft: s, warp count: 13, weft count: 10. Frag. 5: 191/78. Description of find: loose fragments. Weave: basket weave, spin warp: sz, spin weft: ss,zs, zz, warp count: 6, weft count: 7. Date: Hallstatt C, Date of record: 1987-08-18.

62: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum QU 77, 250/78 grave 127. Description of find: Iron knife with encrusted textile remains. Weave: 2/2 twill, spin warp: z,s, spin weft: s, warp count: 7, weft count: 8, Date: Hallstatt C, Date of record: 1987-08-18.

63: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum 383/79 grave 209. Description of find: Iron Mehrkopfnadel with encrusted textile remains. Weave: 2/2 twill, spin warp: z,s, spin weft: z,s, warp count: 14, weft count: 12, Date: Hallstatt C, Date of record: 1987-08-18.

64: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum QU 88, 531/80 grave 239. Description of find: Iron fragments with encrusted textile remains. Weave: 2/2 twill, spin warp: s, spin weft: s, warp count: 8, weft count: 7, Date: Hallstatt C, Date of record: 1987-08-18.

65: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum QU 131, 550-52/80 grave 250. Description of find: Fragment of iron mount with encrusted textile fragment. Weave: tabby, spin warp: z, spin weft: z, warp count: 4, weft count: 4, Date: Hallstatt C, Date of record: 1987-08-18.

66: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum QU 141, 303/81 grave 258. Description of find: Iron pin with textile remains. Weave: 2/2 twill, spin warp: 12z,12s, spin weft: z,s, warp count: 22, weft count: 24, Date: Hallstatt C, Date of record: 1987-08-18.

67: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum QU 141, 310/81 grave 259. Description of find: Bronze mount with textile remains. Weave: 2/2 twill, spin warp: z,s, spin weft: z,s, warp count: 17, weft count: 18, Date: Hallstatt C, Date of record: 1987-08-18.

68: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum 465/81-82 grave 273. Description of find: Iron fragments with textile remains. Weave: tabby, spin warp: s, spin weft: s, warp count: 6, weft count: 12, Date: Hallstatt C, Date of record: 1987-08-18.

69: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum 1139/83 grave 378. Description of find: Iron knife fragment with textile remains. Weave: 2/2 twill, spin warp: z,s, spin weft: z,s, warp count: 15, weft count: 18, Date: Hallstatt C, Date of record: 1987-08-18.

70: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum 1140/83 grave 382. Description of find: Iron fragments with textile remains. Weave: 2/2 twill, spin warp: z,s , spin weft: s, warp count: 12, weft count: 11, Date: Hallstatt C, Date of record: 1987-08-18.

71: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum 1149/83 grave 384. Description of find: Iron fragment with encrusted textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 7, weft count: 8, Date: Hallstatt C, Date of record: 1987-08-18.

72: Uttendorf im Pinzgau, Salzburg-Land. Salzburger Museum Carolino Augusteum 1115/83 grave 386. Description of find: Encrusted textile remains. Weave: 2/2 twill, spin warp: z,s, spin weft: z,s, warp count: 16, weft count: 16, Date: Hallstatt C, Date of record: 1987-08-18.

73: Dürrnberg Salzbergwerk, Hallein, Salzburg-Land. Salzburger Museum Carolino Augusteum. Description of find: Textile fragment 1. Weave: 2/2 twill, spin warp: S2z, spin weft: z, warp count: 11, weft count: 12, fibre: wool. Textile fragment 2: Weave: tabby, spin warp: S2z, spin weft: z, warp count: 9, weft count: 9, fibre: wool, Date: La TèneA, Date of record: 1987-08-18.

74: Lehen, Mitterkirchen, Oberösterreich. Oberösterreichisches Landesmuseum Linz, mound II grave 1, fragment 1. Description of find: Iron fragment with textile impression. Weave: repp, spin warp: -, spin weft: s, warp count: 8, weft count: 46. Fragment 2: Description of find: Iron fragment with textile remains. Weave: repp, spin warp: Z2s, spin weft: s, warp count: 5, weft count: 34. Fragment 3: Description of find: Weave: repp, spin warp: -, spin weft: s, warp count: 8, weft count: 36. Fragment 4: Description of find: Iron fragment with textile impression. Weave: repp, spin warp: Z2s, spin weft: s, warp count: - weft count: - Date: Hallstatt C, Date of record: 1987-08-27.

75: Schusterwald Höch, Steiermark. Steiermärkisches Landesmuseum Joanneum Graz 18212 mound 24. Description of find: Encrusted textile remains. Weave: 2/2 twill, spin warp: S2z, spin weft: s, warp count: 8, weft count: 5, Date: Hallstatt, Date of record: 1987-08-31.

76: Hallstatt, Oberösterreich. Naturhistorisches Museum Wien 23829 grave 57. Description of find: Iron sword? with encrusted textile remains. Weave: basket weave, spin warp: zz, spin weft: zz, warp count: 14, weft count: 8, Date: Hallstatt, Date of record: 1987-02-09.

77: Hallstatt, Oberösterreich. Naturhistorisches Museum Wien 23888 grave 75. Description of find: Bronze ring with encrusted textile impression. Weave: 2/2 twill, spin warp: z,s, spin weft: z,s , warp count: 17, weft count: 18, Date: Hallstatt, Date of record: 1987-02-09.

78: Hallstatt, Oberösterreich. Naturhistorisches Museum Wien 24480 grave 260. Fragment 1. Description of find: Sword fragment with encrusted textile remains. Weave: repp, spin warp: S2z, spin weft: -, warp count: 17, weft count: 7. Fragment 2: Description of find: Sword handle with textile remains. Weave: repp, spin warp: S2z, spin weft: -, warp count: 15, weft count: 6, Date: Hallstatt C, Date of record: 1987-02-09.

79: Hallstatt, Oberösterreich. Naturhistorisches Museum Wien 24514 grave 271. Description of find: Stone pendant with textile remains. Weave: 2/2 twill, spin warp: 4z,4s, spin weft: 4z,4s, warp count: 27, weft count: 28, Date: Hallstatt. Date of record: 1987-02-09.

80: Hallstatt, Oberösterreich. Naturhistorisches Museum Wien 24554 grave 283. Description of find: Iron hammerhead? with encrusted textile remains. Weave: 2/2 twill, spin warp: z,s, spin weft: z,s, warp count: 16, weft count: 15, Date: Hallstatt, Date of record: 1987-02-09.

81: Hallstatt, Oberösterreich. Naturhistorisches Museum Wien 25161. Description of find: Iron sword wrapped in encrusted textile impression. Weave: repp , spin warp: z, spin weft: -, warp count: 20, weft count: 12, Date: Hallstatt, Date of record: 1987-02-09.

82: Hallstatt, Oberösterreich. Naturhistorisches Museum Wien 25235 grave 504. Description of find: Sword fragments with remains of scabbard wrapping. Weave: repp, spin warp: S2z, spin weft: -, warp count: 17, weft count: 7, Date: Hallstatt. Date of record: 1987-02-09.

83: Hallstatt, Oberösterreich. Naturhistorisches Museum Wien 26060 grave 792. Description of find: Iron axe with encrusted textile remains. Weave: repp, spin warp: z,s, spin weft: z,s, warp count: 29, weft count: 14, Date: Hallstatt D, Date of record: 1987-02-09.

84: Hallstatt, Oberösterreich. Naturhistorisches Museum Wien 26474 grave 937. Description of find: Sickle-shaped knife with encrusted textile remains. Weave: 2/2 twill, spin warp: z,s, spin weft: z,s, warp count: 20, weft count: 16, Date: Hallstatt. Date of record: 1987-02-09.

85: Schrattenberg, Mistelbach a d Zaya, Niederösterreich. Naturhistorisches Museum Wien 79550. Description of find: Hollow bronze arm ring with textile filling. Weave: tabby, spin warp: z, spin weft: z, warp count: 19, weft count: 18, fibre: flax?, Date: La Tène B, Date of record: 1987-03-09.

Slovenia

86: Brezje, Krain. Naturhistorisches Museum Wien 33845 XIII:24:p grave 5. Description of find: Iron lance with encrusted textile impression. Weave: tabby, spin warp: s or S2z, spin weft: s or S2z, warp count: 8, weft count: 6, Date: Hallstatt C, Date of record: 1987-02-09.

87: Germ, Podsemel, Mötting, Krain. Naturhistorisches Museum Wien 66855 b(30.IV, 1888). Description of find: Iron lance with textile impression. Weave: tabby, spin warp: -, spin weft: -, warp count: 11, weft count: 10, Date: Hallstatt, Date of record: 1987-02-09.

88: Germ Podsemel, Mötting, Krain. Naturhistorisches Museum Wien 66808 1a(IV 1888). Description of find: Lump of bronze rings with textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 9, weft count: 10, Date: Hallstatt. Date of record: 1987-02-09.

89: Germ Podsemel, Mötting, Krain. Naturhistorisches Museum Wien 67194 tumulus 1i. Description of find: Boat fibula with encrusted textiles around head. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 7, weft count: 12. Fragment 2: Naturhistorisches Museum Wien 67201. Description of find: Iron fragment with textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 8, weft count: 10, Date: Hallstatt D3, Date of record: 1987-02-09.

90: Klenik, Vače, Krain. Naturhistorisches Museum Wien 3570 Find 4. Description of find: Iron arm ring with encrusted textile remains. Weave: tabby, spin warp: s, spin weft: s, warp count: 10, weft count: 8, Date: Hallstatt, Date of record: 1987-02-09.

91: Mihovo St Bartolina, Krain. Naturhistorisches Museum Wien 53319, grave 11. Description of find: Boat fibula with cord around head. String, z-twisted. Date: Hallstatt D3, Date of record: 1987-03-09.

92: Mihovo St Bartolina, Krain. Naturhistorisches Museum Wien 53423 grave 60. Description of find: Boat fibula with remains of string around head. String, Szzzzz. Date: Hallstatt D3, Date of record: 1987-03-09.

93: Podsemel, Krain. Naturhistorisches Museum Wien 88899. Description of find: Boat fibula with textile remains on head and foot. Weave: 2/2 twill, spin warp: z,s, spin weft: z, warp count: 10, weft count: 8, Date: Hallstatt D3, Date of record: 1987-02-09.

94: Roviše St. Margarethen, Krain. Naturhistorisches Museum Wien 7798 XIII,8,1B. Description of find: Lance head with textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 7, weft count: 8, Date: Hallstatt, Date of record: 1987-02-09.

95: Roviše St. Margarethen, Krain. Naturhistorisches Museum Wien 7822 tumulus 1. Description of find: Belt mount partly covered by textile. Weave: tabby, spin warp: z, spin weft: s, warp count: 14, weft count: 13, Date: Hallstatt, Date of record: 1987-02-09.

96: Skrile Podsemel, Möttling, Krain. Naturhistorisches Museum Wien 67394 19.X.1887 5. Description of find: Small iron fragment encrusted with textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 14, weft count: 8, Date: Hallstatt, Date of record: 1987-02-09.

97: Skrile, Podsemel, Möttling, Krain. Naturhistorisches Museum Wien 67423 16. Description of find: Bronze fibula with textile remains on foot. Weave: 2/2 twill, spin warp: s, spin weft: 3z,1s, warp count: 13, weft count: 10, Date: Hallstatt, Date of record: 1987-02-09.

98: Šmarje, Magdalenska Gora, Grosuple. Krain. Naturhistorisches Museum Wien 86602 XIII,5,3 grave 57, fragment 1. Description of find: Bronze belt mount with encrusted textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 7, weft count: 8, fibre: wool. Fragment 2: Weave: 2/2 twill, spin warp: s, spin weft: s, warp count: 20, weft count: 20, fibre: wool. Fragment 3, Naturhistorisches Museum Wien 86603. Description of find: Rectangular belt mounts covered by textile remains. Weave: 2/2 twill, spin warp: z, spin weft: s, warp count: 19, weft count: 20, Date: Hallstatt, Date of record: 1987-02-09.

99: Šmarje, Magdalenska Gora, Grosuple, Krain. Naturhistorisches Museum Wien 86714, grave 74. Description of find: Bronze belt mount with textile impression. Weave: 2/2 twill, spin warp: -, spin weft: -, warp count: 5, weft count: 6, Date: Hallstatt, Date of record: 1987-02-09.

100: Šmarje, Magdalenska Gora, Grosuple, Krain. Naturhistorisches Museum Wien 86762 VI. Description of find: Bronze ring with encrusted textile remains. Weave: 2/1 twill?, spin warp: z, spin weft: s, warp count: 18, weft count: 15, Date: Hallstatt, Date of record: 1987-02-09.

101: St Michael, Adelsberg, Krain. Naturhistorisches Museum Wien 48764 grave 29. Description of find: Iron object with textile remains. Weave: 2/2 broken/diamond twill, spin warp: s, spin weft: s, warp count: 12, weft count: 22, Date: Hallstatt, Date of record: 1987-02-09.

102: St. Michael, Adelsberg, Krain. Naturhistorisches Museum Wien 81123. Description of find: Iron fragment with textile remains. Weave: tabby, spin warp; s, spin weft: s, warp count: 8, weft count: 7, Date: Hallstatt, Date of record: 1987-02-09.

103: Tschernembl, Krain. Naturhistorisches Museum Wien 37654, tumulus I, grave 2. Description of find: Iron arm ring with encrusted textile remains. Weave: 2/2 twill, spin warp: z, s, spin weft: z,s, warp count: 11, weft count: 11. Fragment 2: Naturhistorisches Museum Wien 37648. Description of find: Iron fragment with encrusted textile fragments. Weave: 2/2 twill, spin warp: 4z,2s, spin weft: z,s, warp count: 13, weft count: 12, Date: Hallstatt, Date of record: 1987-02-09.

104: Insel Veglia, Bescanova. Naturhistorisches Museum Wien 72574 grave 3. Description of find: Bronze fibula with textile remains around head. Weave: 2/2 twill, spin warp: z,s, spin weft: z, warp count: 14, weft count: 12, Date: Hallstatt D/La Tène A, Date of record: 1987-03-09.

105: Vače, Tittai, Krain. Naturhistorisches Museum Wien 6504 XIII:8,6. Description of find: Bow fibula with encrusted textile remains around pin holder. Weave: 2/2 twill, spin warp: z,s, spin weft: z,s, warp count: 10, weft count: 11, Date: Hallstatt D, Date of record: 1987-02-09.

106: Vače, Tittai, Krain. Naturhistorisches Museum Wien 6564. Description of find: Iron knife with encrusted textile remains. Weave: 2/2 twill, spin warp: s, spin weft: s, warp count: 7, weft count: 8, Date: Hallstatt, Date of record: 1987-02-09.

107: Vače, Tittai, Krain. Naturhistorisches Museum Wien 6575. Description of find: Fragments of bow fibula with encrusted textile remains. Weave: 2/2 twill, spin warp: s, spin weft: s, warp count: 10, weft count: 9, Date: Hallstatt, Date of record: 1987-02-09.

108: Vače, Tittai, Krain. Naturhistorisches Museum Wien 6579 XIII,8,7. Fragment. 1. Description of find: Iron ring with encrusted textile remains. Weave: 2/2 twill, spin warp: 8z,8s, spin weft: 6z,6s, warp count: 24, weft count: 19. Fragment 2: Description of find: Iron armring with encrusted textile remains. Weave: 2/2 twill, spin warp: s, spin weft: s, warp count: 10, weft count: 7, Date: Hallstatt, Date of record: 1987-02-09.

109: Vače, Tittai, Krain. Naturhistorisches Museum Wien 6598. Description of find: Iron fragments with encrusted textile remains. Weave: 2/2 twill, spin warp: 6z,6s, spin weft: 6z,6s, warp count: 15, weft count: 24, Date: Hallstatt, Date of record: 1987-02-09.

110: Vače, Tittai, Krain. Naturhistorisches Museum Wien 6704 1882. Description of find: Iron axe with encrusted textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 18, weft count: 19, Date: Hallstatt, Date of record: 1987-02-09.

111: Vače, Tittai, Krain. Naturhistorisches Museum Wien 8003, grave 43. Description of find: Bronze axe with textile remains on blade. Weave: 2/2 twill, spin warp: z,s, spin weft: z,s, warp count: 18, weft count: 19, Date: Hallstatt, Date of record: 1987-02-09.

112: Vače, Tittai, Krain. Naturhistorisches Museum Wien 8515. Description of find: Iron rod with encrusted textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 12, weft count: 14, Date: Hallstatt, Date of record: 1987-02-09.

113: Vače, Tittai, Krain. Naturhistorisches Museum Wien 14192. Description of find: Iron fragment with bronze flakes and encrusted textile remains. Weave: 2/2 twill, spin warp: -, spin weft: -, warp count: 16, weft count: 12, Date: Hallstatt, Date of record: 1987-02-09.

114: Vače, Tittai, Krain. Naturhistorisches Museum Wien 14196, XIII,10,3. Description of find: Iron ring with encrusted textile remains. Weave: 2/2 twill, spin warp: s, spin weft: z,s, warp count: 22, weft count: 20, Date: Hallstatt, Date of record: 1987-02-09.

115: Vače, Tittai, Krain. Naturhistorisches Museum Wien 14216. Description of find: Fragments of large iron bow fibula with encrusted textile remains. Weave: 2/2 twill, spin warp: s, spin weft: s, warp count: 12, weft count: 14, Date: Hallstatt, Date of record: 1987-02-09.

116: Vače, Tittai, Krain. Naturhistorisches Museum Wien 14218, 1887, XIII,19, p. 1: Description of find: Bow fibula and bronze armring w encrusted textile remains. Weave: 2/2 twill, spin warp: z,s, spin weft: s, warp count: 12, weft count: 14. p 2. Description of find: Loose textile fragment. Weave: 2/2 twill, spin warp: s, spin weft: s, warp count: 14, weft count: 14. Date: Hallstatt, Date of record: 1987-02-09.

117: Vače, Tittai, Krain. Naturhistorisches Museum Wien 80938. Description of find: Iron armring with encrusted textile remains. Weave: 2/2 twill, spin warp: s, spin weft: s, warp count: 10, weft count: 6, Date: Hallstatt, Date of record: 1987-02-09.

118: Vače, Tittai, Krain. Naturhistorisches Museum Wien 80944. Description of find: Bronze ring with encrusted textile remains. Weave: tabby, spin warp: s, spin weft: s, warp count: 11, weft count: 8, Date: Hallstatt, Date of record: 1987-02-09.

119: Vače, Tittai, Krain. Naturhistorisches Museum Wien 80948, XIII,10,6. Description of find: Bow fibula with encrusted textile remains. Weave: -, spin warp: S2z?, spin weft: s, warp count: 11, weft count: 6, Date: Hallstatt D, Date of record: 1987-02-09.

120: Vače, Tittai, Krain. Naturhistorisches Museum Wien XIII,11,2A. Description of find: Bronze fibula fragment with encrusted textile remains. Weave: 2/2 twill, spin warp: z,s, spin weft: s(z?), warp count: 8, weft count: 9, Date: Hallstatt, Date of record: 1987-02-09.

121: Vače, Tittai, Krain. Naturhistorisches Museum Wien XIII,11,2c. Description of find: Fragment of iron armring with textile remains. Weave: 2/2 twill, spin warp: 6z,6s, spin weft: 6z,6s, warp count: 11, weft count: 12, Date: Hallstatt, Date of record: 1987-02-09.

122: Vače, Tittai, Krain. Naturhistorisches Museum Wien XIII,11,2d. Description of find: Several iron rings with textile remains. Weave: 2/2 twill, spin warp: 4z,4s, spin weft: z,s, warp count: 12, weft count: 17, Date: Hallstatt, Date of record: 1987-02-09.

123: Vače, Tittai, Krain. Naturhistorisches Museum Wien XIII,11,2b. Description of find: Part of iron ring with encrusted textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 18, weft count: 10, Date: Hallstatt, Date of record: 1987-02-09.

124: Erdöd, Nirobititz, Krain. Naturhistorisches Museum Wien 39915. Description of find: Lance head with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 11, weft count: 10, Date: La Tène, Date of record: 1987-03-09.

125: Roje, Moräntsch, Krain. Naturhistorisches Museum Wien x3621, grave 1. Description of find: Iron knife with faint textile remains. Weave: tabby, spin warp: -, spin weft: -, warp count: 16, weft count: 14, Date: La Tène, Date of record: 1987-03-09.

Switzerland

126: Andelfingen, Kt. Zürich. Schweizerisches Landesmuseum Zürich 22291, grave 12. Description of find: Pointed iron object with encrusted textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 15, weft count: 12, Date: La Tène B, Date of record: 1987-12-08.

127: Andelfingen, Kt. Zürich. Schweizerisches Landesmuseum Zürich 22343-48, grave 21. Description of find: Iron ring with textile fragment. Weave: tabby, spin warp: z, spin weft: z, warp count: 15, weft count: 12, Date: La Tène B, Date of record: 1987-12-08.

128: Andelfingen, Kt. Zürich. Schweizerisches Landesmuseum Zürich 22377-93, grave 29. Description of find: Iron object with encrusted textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 13, weft count: 15, Date: La Tène, Date of record: 1987-12-08.

129: Arbedo-Castione, Kt. Ticino. Schweizerisches Landesmuseum Zürich P 11844, grave 32. Description of find: Iron belt hook with textile remains on back. Weave: 2/2 twill, spin warp: z,s, spin weft: z, warp count: 7, weft count: 7, Date: La Tène A, Date of record: 1987-12-08.

130: Arbedo-Castione, Kt. Ticino. Schweizerisches Landesmuseum Zürich 13579-81, grave 45. Description of find: Iron fibula with faint textile remains. Weave: 2/2 twill?, spin warp z, spin weft: -, warp count 8, weft count: 7, Date: La Tène B, Date of record: 1987-12-08.

131: Arbedo-Cerinasca, Kt. Ticino. Schweizerisches Landesmuseum Zürich 11923-27, grave 10. Description of find: Bronze fibula with textile remains on back. Weave: 2/2 twill, spin warp: z,s, spin weft: z,s, warp count: 20, weft count: 18, Date: Hallstatt D, Date of record: 1987-12-08.

132: Arbedo-Cerinasca, Kt. Ticino. Schweizerisches Landesmuseum Zürich 12446, grave 108. Description of find: Head of bronze fibula with faint textile remains on pin. Weave: 2/2 twill, spin warp: z,s, spin weft: s, warp count: 10, weft count: 10, Date: La Tène A, Date of record: 1987-08-13.

133: Arbedo-Cerinasca, Kt. Ticino. Schweizerisches Landesmuseum Zürich 12492, grave 115. Description of find: Bronze fibula with textile fragment under head. Weave: 2/2 twill, spin warp: z,s, spin weft: s, warp count: 10, weft count: 9, Date: La Tène A/B, Date of record: 1987-08-13.

134: Arbedo-Cerinasca, Kt. Ticino. Schweizerisches Landesmuseum Zürich 12637, grave 140. Description of find: Iron belt hook with encrusted textile fragment. Weave: 2/2 twill?, spin warp: z, spin weft: -, warp count: 11, weft count: 8. SLMZ 12635, grave 140? Description of find: Iron fibula with textile remains under foot. Weave: tabby, spin warp: z?, spin weft: z?, warp count: 6, weft count: 6, Date: La Tène B, Date of record: 1987-08-13.

135: Arbedo-Cerinasca, Kt. Ticino. Schweizerisches Landesmuseum Zürich 12642, grave 149. Description of find: Iron fibula with textile remains on head. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 6, weft count: 6, Date: La Tène B, Date of record: 1987-08-13.

136: Arbedo-Cerinasca, Kt. Ticino. Schweizerisches Landesmuseum Zürich 12645, grave 150. Description of find: Iron fibula with textile remains under spiral. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 8, weft count: 6, Date: La Tène B, Date of record: 1987-08-13.

137: Arbedo-Molinazzi, Kt. Ticino. Schweizerisches Landesmuseum Zürich 11483. Description of find: Iron belt hook with encrusted textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 7, weft count: 8, Date: La Tène A/B, Date of record: 1987-08-13.

138: Arbedo-Molinazzi, Kt. Ticino. Schweizerisches Landesmuseum Zürich 13390, grave 59. Fragment 1. Description of find: Iron fibula with encrusted textile remains. Weave: 2/2 twill, spin warp: z, spin weft: s, warp count: 6, weft count: 6. Fragment 2. Description of find: Iron fibula with encrusted textile remains. Weave: 2/2 twill?, spin warp: z, spin weft: z, warp count: 6, weft count: 6, Date: La Tène A/B, Date of record: 1987-08-13.

139: Arbedo-Molinazzi, Kt. Ticino. Schweizerisches Landesmuseum Zürich 13394, grave 60. Description of find: Large iron fibula with textile remains on ball. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 8, weft count: 7, Date: La Tène C?, Date of record: 1987-08-13.

140: Arbedo-Molinazzi, Kt. Ticino. Schweizerisches Landesmuseum Zürich 13441, grave 69. Description of find: Iron fibula with textile remains on foot. Weave: 2/2 twill, spin warp: 6z,6s, spin weft: 6z,6s, warp count: 11, weft count: 11, Date: La Tène A/B, Date of record: 1987-08-13.

141: Arbedo-Molinazzi, Kt. Ticino. Schweizerisches Landesmuseum Zürich 13472, grave 70. Description of find: Iron ring with encrusted textile remains. Weave: 2/2 twill, spin warp: 4z,4s, spin weft: z, warp count: 9, weft count: 8, Date: La Tène A/B, Date of record: 1987-08-13.

142: Arbedo-Molinazzi, Kt. Ticino. Schweizerisches Landesmuseum Zürich 13530-33, grave 82. Description of find: Iron fibula with textile remains under foot. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 8, weft count: 6, Date: La Tène A/B, Date of record: 1987-08-13.

143: Arbedo-Molinazzi, Kt. Ticino. Schweizerisches Landesmuseum Zürich 13848, grave 87. Description of find: Iron fibula with encrusted textile remains. Weave: 2/2 twill, spin warp: z,s, spin weft: z, warp count: 10, weft count: 10, Date: La Tène A, Date of record: 1987-08-13.

144: Arbedo-Molinazzi, Kt. Ticino. Schweizerisches Landesmuseum Zürich 131xx. Description of find: Iron fibula with textile remains under head. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 8, weft count: 7, Date: La Tène A/B, Date of record: 1987-08-13.

145: Arbedo-Molinazzi, Kt. Ticino. Schweizerisches Landesmuseum Zürich no number. Description of find: Iron fibula with textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 8, weft count: 8, Date: La Tène B, Date of record: 1987-08-13.

146: Arbedo-S. Paolo, Kt. Ticino. Schweizerisches Landesmuseum Zürich 13014, grave 1. Description of find: Iron ring with encrusted textile remains. Weave: 2/2 twill, spin warp: -, spin weft: -, warp count: 8, weft count: 7, Date: La Tène A, Date of record: 1987-08-13.

147: Arbedo-S. Paolo, Kt. Ticino. Schweizerisches Landesmuseum Zürich 13020-23, grave 3. Description of find: Iron fibula with encrusted textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 8, weft count: 7, Date: La Tène A, Date of record: 1987-08-13.

148: Kastell, Bellinzona, Kt. Ticino. Schweizerisches Landesmuseum Zürich, no number. Description of find: Iron fibula with textile remains underpin. Weave: 2/2 twill, spin warp: z,s, spin weft: z, warp count: 7, weft count: 8, Date: La Tène A/B, date of record: 1987-08-13.

149: Castione-Bergamo, Kt. Ticino. Schweizerisches Landesmuseum Zürich 12996, grave 14. Description of find: Iron fibula with encrusted textile remains. Weave: 2/2 twill?, spin warp: -, spin weft: -, warp count: 10, weft count: 9, Date: La Tène A/B, Date of record: 1987-08-13.

150: Frauenfeld-Langdorf, Kt. Thurgau. Schweizerisches Landesmuseum Zürich 19065, grave 3. Description of find: Iron fibula with textile remains on underside. Weave: tabby, spin warp: z, spin weft: z, warp count: 6, weft count: 5, Date: La Tène C, Date of record: 1987-08-13.

151: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 14004, grave 24. Description of find: Iron belt hook with faint textile remains. Weave: 2/2 twill?, spin warp: z, spin weft: z, warp count: 10, weft count: 8, Date: La Tène B, Date of record: 1987-08-13.

152: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 14091, grave 51. Description of find: Iron fibula with faint textile remains under head. Weave: tabby, spin warp: z, spin weft: s, warp count:6, weft count: 6, Date: La Tène B, Date of record: 1987-08-13.

153: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 14138, grave 61. Description of find: Iron fibula with textile remains under spiral. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 6, weft count: 7, Date: La Tène A/B, Date of record: 1987-08-13.

154: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 14170, grave 68. Description of find: Iron belt buckle with encrusted textile remains. Weave: 2/2 twill, spin warp: z,s, spin weft: z, warp count: 8, weft count: 8, Date: La Tène B/C, Date of record: 1987-08-13.

155: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 14313, grave 78. Description of find: Iron fibula with encrusted textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 10, weft count: 8, Date: La Tène B, Date of record: 1987-08-13.

156: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 14311, grave 79. Description of find: Fragment of iron fibula with encrusted textile remains under head. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 7, weft count: 6, Date: La Tène B, Date of record: 1987-08-13.

157: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 14575, grave 109. Description of find: Iron fibula with textile remains under head. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 7, weft count: 8, Date: La Tène C, Date of record: 1987-08-13.

158: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 14580, grave 110. Description of find: Iron object partly covered by encrusted textile remains. Weave: - spin warp: z, spin weft: -, warp count: 9, weft count: -, Date: La Tène A, Date of record: 1987-08-13.

159: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 14669, grave 122. Description of find: Iron ring with encrusted textile remains. Weave: 2/2 twill, spin warp: z, spin weft: -, warp count: 10, weft count: 8, Date: La Tène A/B, Date of record: 1987-08-13.

160: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 14914, grave 145. Description of find: Iron fibula with textile remains under head. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 8, weft count: 7, Date: La Tène C, Date of record: 1987-08-13.

161: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 14922, grave 147. Fragment 1. Description of find: Iron fibula with textile remains under foot. Weave: 2/2 twill, spin warp: z, spin weft: s, warp count: 9, weft count: 7. Fragment 2. 14294. Description of find: Iron fibula partly covered by encrusted textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 9, weft count: 6, Date: La Tène B/C, Date of record: 1987-08-13.

162: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 14968, grave 161. Description of find: Iron fibula with textile remains on foot. Weave: 2/2 twill, spin warp: z, spin weft: -, warp count: 8, weft count: 8, Date: La Tène B, Date of record: 1987-08-14.

163: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 14974, grave 164. Description of find: Iron fibula with textile remains under foot. Weave: 2/2 twill, spin warp: z, spin weft: s, warp count: 8, weft count: 7, Date: La Tène B/C, Date of record: 1987-08-14.

164: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 14988, grave 177. Description of find: Iron fibula with encrusted textile remains. Weave: 2/2 twill, spin warp: z, spin weft: s, warp count: 6, weft count: 5, Date: La Tène B, Date of record: 1987-08-14.

165: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 14998, grave 194. Description of find: Iron fibula with encrusted textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 6, weft count: 8. Fragment 2. 14141 grave 194? Description of find: Iron knife with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 14, weft count: 9, Date: La Tène B/C, Date of record: 1987-08-14.

166: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 15040, grave 211. Description of find: Iron fibula with textile remains under foot. Weave: 2/2 twill, spin warp: z,s, spin weft: z, warp count: 8, weft count: 6, Date: La Tène A/B, Date of record: 1987-08-14.

167: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 15043, grave 213. Description of find: Iron fibula with encrusted textile remains on bow. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 8, weft count: 5, Date: La Tène B, Date of record: 1987-08-14.

168: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 15060, grave 216. Description of find: Iron fibula with faint textile remains under foot. Weave: 2/2 twill, spin warp: z,s, spin weft: z,s, warp count: 9, weft count: 8, Date: La Tène B/C, Date of record: 1987-08-14.

169: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 15071, grave 222. Description of find: Iron fibula with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 5, weft count: 5, Date: La Tène D, Date of record: 1987-08-14.

170: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 15091, grave 227. Description of find: Iron fibula with textile remains on bow. Weave: tabby, spin warp: z, spin weft: z, warp count: 5, weft count: 5, Date: La Tène B, Date of record: 1987-08-14.

171: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 15181, grave 243. Description of find: Iron fibula with textile remains under head. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 6, weft count: 7, Date: La Tène A/B, Date of record: 1987-08-14.

172: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 15539, grave 305. Description of find: Iron fibula with encrusted textile remains on foot. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 8, weft count: 6, Date: La Tène B/C, Date of record: 1987-08-14.

173: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 15773, grave 398. Description of find: Iron fibula with textile remains around pin and foot. Weave: 2/2 twill, spin warp: 4z,4s, spin weft: 4z,4s, warp count: 9, weft count: 8, Date: La Tène B, Date of record: 1987-08-14.

174: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 15783, grave 404. Description of find: Iron belt? with textile fragment. Weave: tabby, spin warp: z, spin weft: z, warp count: 6, weft count: 7, Date: La Tène, Date of record: 1987-08-14.

175: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 15979, grave 444. Description of find: Iron fragment with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 8, weft count: 9. SLMZ 15978: Description of find: Iron fibula with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 7, weft count: 6, Date: La Tène B/C, Date of record: 1987-08-14.

176: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich, 16724, grave 477. Description of find: Iron fibula fragment with encrusted textile remains. Weave: tabby, spin warp: z, spin weft: -, warp count: 6, weft count: 5, Date: La Tène, Date of record: 1987-08-14.

177: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 16776, grave 498. Description of find: Iron fibula with textile remains. Weave: 2/2 twill, spin warp: z,s, spin weft: z, warp count: 8, weft count: 6, Date: La Tène B, Date of record: 1987-08-14.

178: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 16791, grave 501. Description of find: Iron fibula with encrusted textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 7, weft count: 6, Date: La Tène A/B, Date of record: 1987-08-14.

179: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich 16822, grave 510. Description of find: Bronze pendant with encrusted textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 10, weft count: 6, Date: La Tène A/B, Date of record: 1987-08-14.

180: Giubiasco, Kt. Ticino. Schweizerisches Landesmuseum Zürich no number. Description of find: Iron fibula with textile remains under spiral. Weave: 2/2 twill, spin warp: z, spin weft: -, warp count: 8, weft count: 6, Date: La Tène B, Date of record: 1987-08-14.

181: Misox, Kt. Graubünden. Schweizerisches Landesmuseum Zürich 11785. Description of find: Iron sword with encrusted textile remains. Weave: 2/2 twill, spin warp: z, spin weft: z, warp count: 5, weft count: 5, Date: La Tène B?, Date of record: 1987-08-14.

France

182: Bezange St Marie, Lorraine. Musée Historique Lorrain Nancy XXIV K80. Fragment 1. Description of find: Iron sword with textile remains. Weave: 2/2 twill, spin warp: S2z, spin weft: z, warp count: 5, weft count: 4. Fragment 2. Description of find: Weave: tabby, spin warp: S2z, spin weft: z, warp count: 8, weft count: 5. Fragment 3. Description of find: Weave: 2/2 diamond twill, spin warp: S2z, spin weft: z, warp count: 14, weft count: 20, Date: La Tène A, Date of record: 1987-10-20.

183: Liverdun la Garenne, Lorraine. Musée Historique Lorrain Nancy ML 134.05. Description of find: Bronze fibula with textile remains around spiral. Weave: twill, spin warp: -, spin weft: -, warp count: 5, weft count: -, Date: La Tène A, Date of record: 1987-10-20.

184: Ifs La Dronnerie, Calvados, Normandie. Musée de Normandie Caen D78-3.21, grave 6. Description of find: Iron ring with encrusted textile remains. Weave: 2/2 twill, spin warp: S2z, spin weft: 4z,4s, warp count: 10, weft count: 9, Date: Hallstatt D?, Date of record: 1987-10-28.

185: Poiseul la Perriere, Dept. Cote d'Or , Bourgogne. Musée du Châtillonnais Châtillon-sur-Seine, grave 1. Fragment 1. Description of find: Iron sword with textile remains on blade. Weave: tabby, spin warp: z, spin weft: z, warp count: 14, weft count: 10, Fibre: wool? Fragment 2: Description of find: Weave: tabby , spin warp: z, spin weft: z, warp count: 16, weft count: 9, fibre: wool?, Date: Hallstatt C, Date of record: 1987-04-11.

186: Poiseul la Perriere, Dept. Cote d'Or, Bourgogne. Musée du Châtillonnais Châtillon-sur-Seine, grave 3. Description of find: Iron sword with textile remains on blade. Weave: tabby, spin warp: z, spin weft: z, warp count: 16, weft count: 9, Date: Hallstatt C, Date of record: 1987-04-11.

187: Poiseul la Perriere, Dept. Cote d'Or, Bourgogne. Musée du Châtillonnais Châtillon-sur-Seine, grave 4. Description of find: Iron sword with textile remains on blade. Weave: tabby, spin warp: z, spin weft: z, warp count: 19, weft count: 19, Date: Hallstatt C, Date of record: 1987-04-11.

Germany

188: Budenheim, Kr Mainz, Rheinland-Pfalz. Mittelrheinisches Landesmuseum Mainz, 1334/1834? Description of find: Iron fragments with textile remains. Weave: 2/2 twill, spin warp: z, spin weft: -, warp count: 10, weft count: 10, Date: La Tène, Date of record: 1987-01-06.

189: Schwabsburg, Kr Mainz, Rheinland-Pfalz. Mittelrheinisches Landesmuseum Mainz V-1104-1108. Description of find: Iron fragment (bow fibula) with textile impression on side. Weave: tabby, spin warp: S2z, spin weft: z, warp count: 11, weft count: 10, Date: La Tène A, Date of record: 1987-01-06.

190: Udenheim, Rheinland-Pfalz. Mittelrheinisches Landesmuseum Mainz 97/1bv B. Description of find: Iron fragment with textile remains. Weave: repp/tablet?, spin warp: S2z, spin weft: -, warp count: 19, weft count: 9, Date: La Tène B/D, Date of record: 1987-01-06.

191: Ülversheim, Rheinland-Pfalz. Mittelrheinisches Landesmuseum Mainz 59/4, grave III, fragment 1. Description of find: Iron pincer with textile remains. Weave: ,Spin warp: z, spin weft: z, warp count: 7, weft count: 6. Fragment 2. Description of find: Iron shears with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 9, weft count: 7, Date: La Tène, Date of record: 1987-04-06.

192: Breungenborn, Kr Birkenfeld, Rheinland-Pfalz. Rheinisches Landesmuseum Trier, 70,949a-f, tumulus 34, grave 9. Fragment 1. Description of find: Iron razor wrapped in textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 5, weft count: 7, fibre: wool. Fragment 2. Description of find: Weave: tabby, spin warp: S2z, spin weft: z, warp count: 10, weft count: 7. Fragment 3. Description of find: Iron ring with textile fragment. Weave: tabby, spin warp: S2z , spin weft: z, warp count: -, weft count: -, Date: La Tène A, Date of record: 1987-10-06.

193: Hasborn Kr Wittlich, Rheinland-Pfalz. Rheinisches Landesmuseum Trier ev 41,31. Description of find: Iron fibula fragment with textile remains. Weave: tabby, spin warp: -, spin weft: -, warp count: 10, weft count: 10, Date: La Tène B/D; Date of record: 1987-11-06.

194: Heinzerath Kr Bernkastel-Kues, Rheinland-Pfalz. Rheinisches Landesmuseum Trier 36,368d, tumulus 1, grave 1. Description of find: Iron fragment (sword) with textile remains. Weave: tabby, spin warp: S2z, spin weft: z, warp count: 5, weft count: 5, fibre: wool? Date: Hunsrück-Eiffel Kultur. Date of record: 1987-09-06.

195: Hermeskeil Kr Trier, Rheinland-Pfalz. Rheinisches Landesmuseum Trier 5808-12. Description of find: Bronze armring with textile fragment. Weave: tabby, spin warp: S2z, spin weft: z, warp count: 7, weft count: 8, fibre: wool? Date: Hunsrück-Eiffel Kultur. Date of record: 1987-11-06.

196: Hoppstädten Kr Birkenfeld, Rheinland-Pfalz. Rheinisches Landesmuseum Trier 52,285, tumulus 2. Fragment 1. Description of find: Cakes of corroded textile. Weave: tabby, spin warp: z, spin weft: S2z?, warp count: 9, weft count: 10. Fragment 2. Description of find: Bbronze ring with textile remains. Weave: 2/2 twill, spin warp: S2z, spin weft: z, warp count: 9, weft count: 9, Date: La Tène A, Date of record: 1987-10-06.

197: Irsch Kr Saarburg, Rheinland-Pfalz. Rheinisches Landesmuseum Trier 38,xxx, tumulus 2. Description of find: Fibula with textile fragment. Weave: sprang?, Spin: z, Date: Hunsrück-Eiffel Kultur, Date of record: 1987-10-06.

198: Rascheid Kr Trier, Rheinland-Pfalz. Rheinisches Landesmuseum Trier 19353a, tumulus D2. Fragment 1. Description of find: Iron armring with textile remains. Weave: tabby, spin warp: S2z, spin weft: z, warp count: 7, weft count: 6. Fragment 2. Description of find: Iron sword with sheath and textile remains. Weave: tabby, spin warp: -, spin weft: -, warp count: 9, weft count: 8. Date: Hunsrück-Eiffel Kultur. Date of record: 1987-10-06.

199: Trier Paulinstrasse, Kr Trier, Rheinland-Pfalz. Rheinisches Landesmuseum Trier 5028. Description of find: Iron sword with textile remains on scabbard. Weave: 2/2 twill, spin warp: -, spin weft: -, warp count: 8, weft count: 8, Date: La Tène A, Date of record: 1987-10-06.

200: Wallscheid Kr Wittlich, Rheinland-Pfalz. Rheinisches Landesmuseum Trier 1017. Description of find: Several textile fragments from bronze bowl. Weave: tabby, spin warp: S2z, spin weft: z, warp count: 17, weft count: 12, fibre: wool, Date: La Tène A, Date of record: 1987-11-06.

201: Bescheid Kr Trier-Saalburg, Rheinland-Pfalz. Rheinisches Landesmuseum Trier, tumulus 124 gr 1. Fragment 1. Description of find: Fragments of band. Weave: tablet weave, spin warp: S2z, spin weft: -. Fragment 2. Description of find: Two repp bands. Weave: repp, spin warp: S2z, spin weft: s, warp count: 33, weft count: 12. Fragment 3. Description of find: Small textile fragment. Weave: tabby, spin warp: s, spin weft: s, warp count: 12, weft count: 12, Date: Hallstatt D, Date of record: 1987-12-06.

202: Beilngries Eichstadt, Bayern. Bayrisches Nationalmuseum München 1920.537-540, 1902, grave 1. Description of find: Iron spiral with textile remains. Weave; 2/2 twill, spin warp: z,s, spin weft: S2z, warp count: 17, weft count: 15, Date: Hallstatt, Date of record: 1987-06-22.

203: Uffing Ldkr Garmisch-Partenkirchen, Bayern. Bayrisches Nationalmuseum München 1203-1204, grave 5. Description of find: Iron objects with encrusted textile remains. Weave: 2/2 twill, spin warp: z, spin weft: s, warp count: 10, weft count: 12, Date: Hallstatt D1, Date of record: 1987-06-22.

204: Aufhausen I Ldkr Harnberg, Bayern. Bayrisches Nationalmuseum München 1895.156, grave 9. Description of find: Iron spirals with encrusted textile remains. Weave: 2/2 twill, spin warp: S2z, spin weft: z, warp count: 10, weft count: 9, Date: Hallstatt, Date of record: 1987-06-22.

205: Schirndorf, Ldkr Schwandorf, Bayern. Bayrisches Nationalmuseum München 1976, 1520d, grave 20. Description of find: Iron object with encrusted textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 10, weft count: -, Date: Hallstatt, Date of record: 1987-06-22.

206: Prächting Ldkr Lichtenfels, Bayern. Bayrisches Nationalmuseum München 4729b1, tumulus 55. Description of find: Iron ring with textile remains. Weave: 2/2 twill, spin warp: S2z, spin weft: z, warp count: 9, weft count: 11, Date: Hallstatt, Date of record: 1987-06-22.

207: Donauwörth Ldkr Donau-Ries, Schwaben. Bayrisches Nationalmuseum München 1979, 1232a, tumulus 2. Description of find: Fragments of iron sword wrapped in textile. Weave: 2/2 twill, spin warp: S2z , spin weft: z, warp count: 20, weft count: 11, Date: Hallstatt, Date of record: 1987-06-22.

208: Schwenderöd Ldkr Amberg-Sulzbach, Oberpfalz. Bayrisches Nationalmuseum München 1895/189.7, tumulus 3. Description of find: Iron fragment with textile remains. Weave: tabby, spin warp: z, spin weft: z, warp count: 11, weft count: 10, Date: La Tène, Date of record: 1987-06-22.

209: Riekofen, Ldkr Regensburg, Oberpfalz. Bayrisches Nationalmuseum München 1279a-h, grave 6. Description of find: Iron fibula with tiny textile remains. Weave: 2/2 twill?, spin warp: z, spin weft: z?, warp count: 10, weft count: 10, Date: La Tène B2, Date of record: 1987-06-22.

210: Aidling/Riegsee Ldkr Weilheim, Oberbayern. Bayrisches Nationalmuseum München 1890.272. Description of find: Iron sword scabbard partly covered by textile impression. Weave: twill?, spin warp: z, spin weft: s, warp count: 40, weft count: -, Date: Hallstatt C, Date of record: 1987-06-23.

211: Bastheim Ldkr Mellrichstadt, Unterfranken. Bayrisches Nationalmuseum München 1965,1474, tumulus 1 grave 1. Description of find: Iron sword partly covered by textile remains. Weave: tabby, spin warp: S2z, spin weft: S2z, warp count: 12, weft count: 12, Date: Hallstatt C, Date of record: 1987-06-22.

212: Hirscheid, Ldkr Bamberg, Bayern. Bayrisches Nationalmuseum München 1975,934e. Description of find: Wood fragments from scabbard with textile remains. Weave: tabby, spin warp: s, spin weft: s, warp count: 26, weft count: 16, Date: Hallstatt, Date of record: 1987-06-23.

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Curriculum vitae

Born in Denmark 1949, educated at the University of Copenhagen (mag. art. 1976, dr. phil 1993). Various posts at museums and universities in Denmark, Sweden and Norway. Teaches archaeology in the Norwegian University of Science & Technology since 1996, since 2002 also textile sciences at the University College Boraas, Sweden. Founding member of the North European Symposium for Archaeological Textiles (NESAT). Current projects: Textilprojekt Mons Claudianus, on textiles and clothing from a Roman quarry in Egypt, and Writing Craftsmanship, on the ontology and epistemology of knowhow.

Main publications on textiles:
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Iron Age Textile artefacts from Riesenferner/Vedretta di Ries (Bolzano/Bozen – Italy)

Marta Bazzanella, Lorenzo Dal Rì, Alfio Masperot† and Irene Tomedi

Abstract

In the summer of 1992, several wool and leather artefacts were found on the edge of a receding snow-field in the Riesenferner group (Bolzano/Bozen-Italy) at a height of 2.850 m. These finds were complementary articles of clothing: a pair of stockings, two pairs of leggings, two inner shoes and many fragments which were probably part of a pair of hide shoes. A radiocarbon date classifies them as belonging to the Early Iron Age.

Im Sommer 1992 wurden in der Nähe der Riesenfernerhütte (Provinz Bozen – Italien) am Rande eines schmelzenden Schneefeldes einige Wolltextilien und Lederreste geborgen. Es handelt sich um ein Paar "Strümpfe" und ein Paar Leggings, um wollene Fussbekleidung und um zahlreiche Bruchstücke von Überschuhen aus Leder. Eine erste Datierung weist in die Eisenzeit.

Discovery of the finds

In the summer of 1992, Gottfried Leitgeb of Anterselva found an item of textile footwear at the limit of a melting snow-field about 200 m from the Vedretta di Ries-Riesenfernerhütte shelter.

After its discovery, the find was brought down to the valley and kept without special care.The find-spot is on the eastern side of the alpine chain, in the Aurine Alps, along the watershed that currently marks the political boundary between Italy and Austria (Fig. 1). More precisely, the find-spot is located in the Vedretta di Ries/Riesenferner

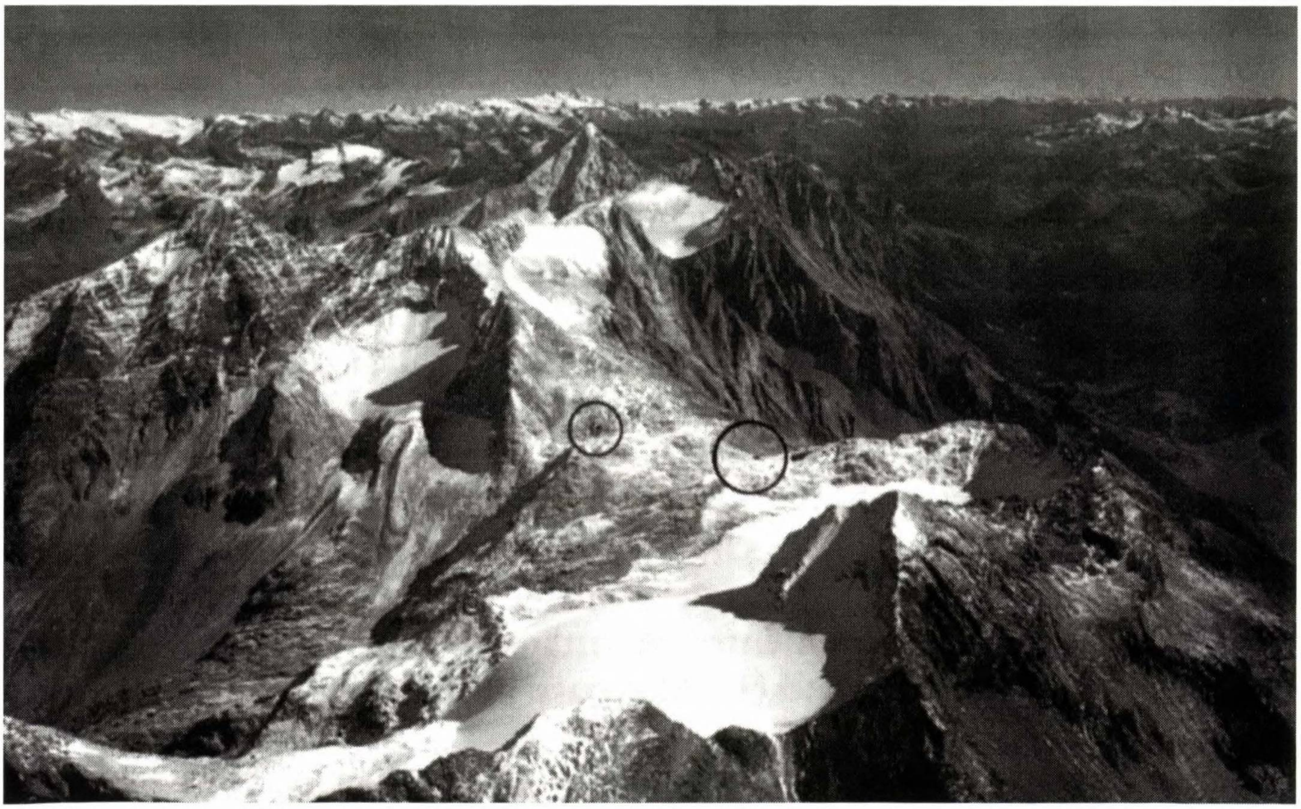

Fig. 1: The Riesenferner glacier with the Riesenferner shelter (large circle) and the find-spot (small circle). On the right the Antholz valley and on the left the Reintal valley (© Tappainer, Lana).

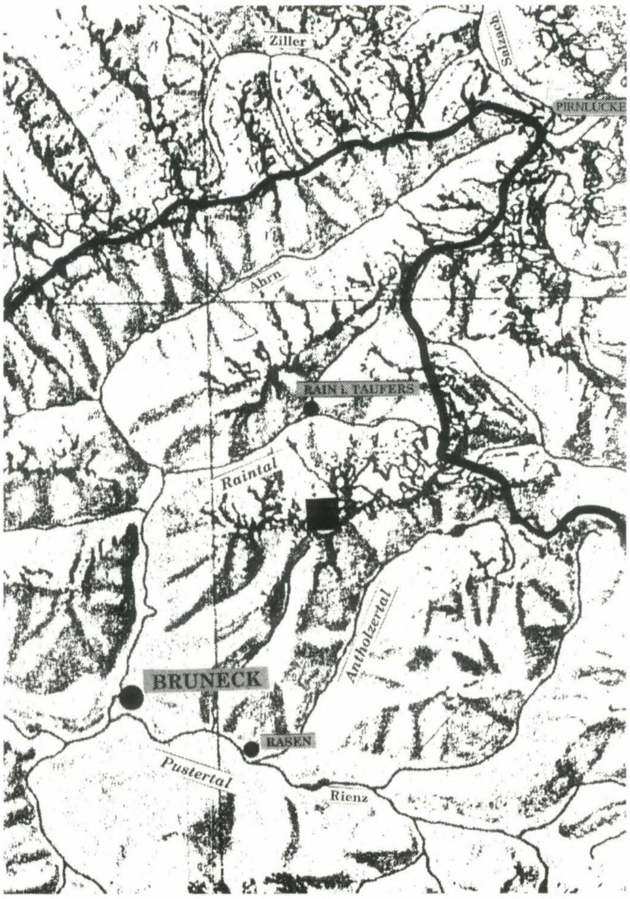

Fig. 2: The Riesenferner glacier: in black the political boundary between Italy and Austria.

group: a massif delimited to the south-east by the Anterselva/Antholz valley and to the north-west by the Riva/Reintal valley. The discovery took place on the western side of the Geltalspitze Mountain at a height of 2.841 m above sea level in a place relate to the so-called "Passo Gemsbichl" (Fig. 2). From here, one follows the Anterselva/Antholz valley which leads into the Pusteria/Pustertal valley some miles south and the Dobbiaco/Doblach pass (1.210 m). This pass is of great historical and geographical relevance for the exchange relationships between north Italy and the Danube basin. Another pass that also had a great importance in the past is the so-called "Passo Pirnlücke", which permits a quick, direct link from the Aurina valley to the Salzach valley. Today it is only frequented by tourists and pastoralists: a far reduced significance compared to its uses in prehistory.

The discovery area is extremely steep, with a slope of about 35°, formed by Oligocenic magmatites.

In August 1994, two years after the discovery, G. Leitgeb noted a retreat of about 5-7 metres of the snow-field limit. Between the overhanging stones, he found other textile and leather fragments. On September 1st 1992, the Ufficio Beni Archeologici (Cultural Heritage) of Bolzano/Bozen took responsibility for their recovery.

The finds include two pairs of leggings and a pair of inner shoes (Fig. 3).

A radiocarbon date placed the textiles between the beginning of 8th and the 5th century BC.[1]

The textiles were submitted for conservation treatment[2], which verified that they were in a good condition of preservation.

The under-leggings

The first pair of leggings (Fig. 4) was made in tabby weave. These leggings are about 62 cm long, 16 cm wide, with a slightly conical shape and a circumference of more than 34 cm. In the lower part, a type of flap is clearly visible. It protrudes from the front and functions to protect the ankle. This flap is destined to be covered by the outer shoes and consists of a single piece of cloth, that is folded and laterally sewn. The threads are thin and single and the textile has an homogeneous appearance. This is due to the simplicity of the weave, and the similarity between the weft and warp threads. On the right legging, there is a simple seam which keeps the two borders together (Fig. 4B, 5). On the left one, the two borders do not touch but are sewn together along the margins of a narrow ribbon (Fig. 4D).

This lateral ribbon is made of two pieces (Fig. 6), which are clearly of different weaving techniques and colours. On the lower extremity, a reinforcement of the borders is

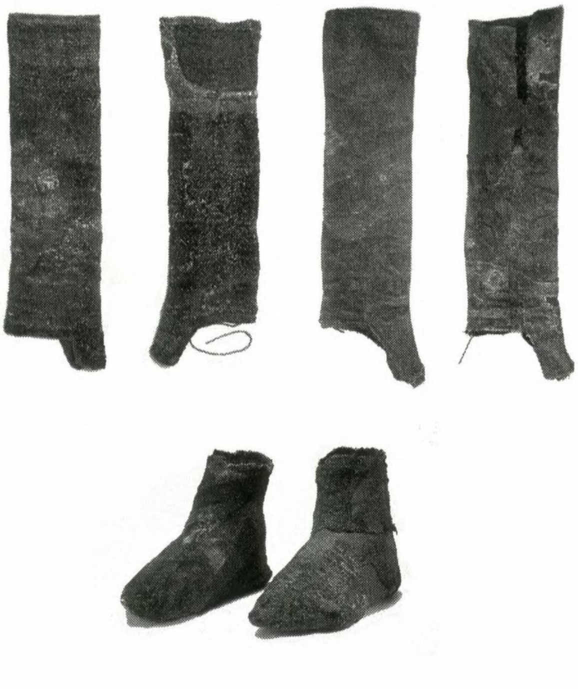

Fig. 3: The finds (© M. Samadelli, South Tyrol Museum of Archaeology, Bozen).

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[1] AMS 14C 13C [0/00] ETH-12932 Nr. 2 BP 252540 -23.91.2 BC/AD 795-499 (98.7%). (Dal Rì 1995-96).

[2] Conducted by Irene Tomedi in Bolzano.

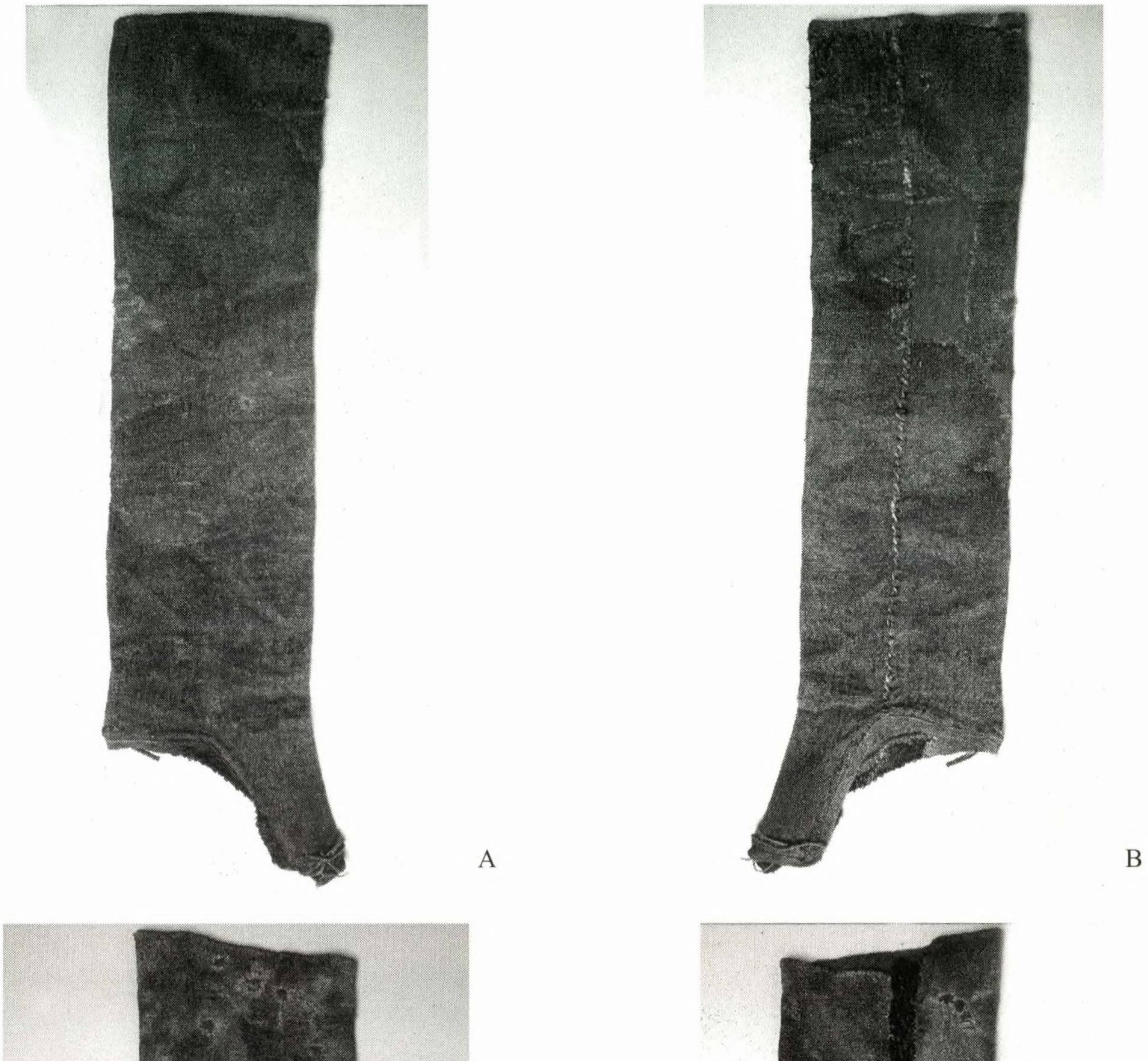


Fig. 4: The under-leggings in tabby: 4A: the outer side of the right legging. – 4B: the inner side of the right legging. – 4C: the outer side of the left legging. – 4D: the inner side of the left legging (© M. Samadelli, South Tyrol Museum of Archaeology, Bozen).

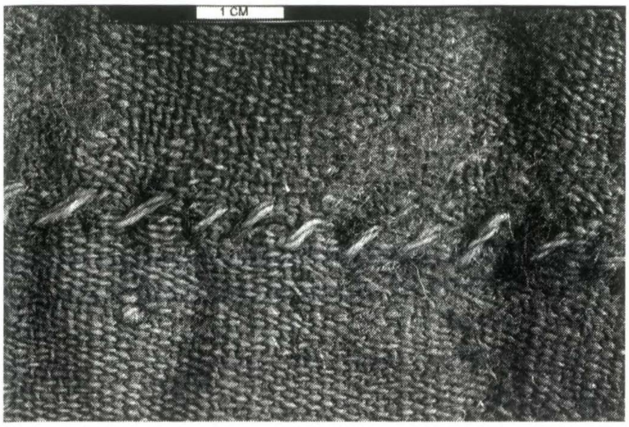


Fig. 5: Seam on the inner side of the right legging (© M. Samadelli, South Tyrol Museum of Archaeology, Bozen).

evident: reinforcement is obtained by the application of a ribbon in brown-red colour, similar to that which constitutes the lateral stripe.

Under-leggings in tabby: technical details

Warp material: natural grey to brown wool, single yarn; spin direction: strong S-twist; density of the fabric 18 per cm

Weft material: natural grey to brown wool, single yarn; spin direction: strong S-twist; density of the fabric: 7 per cm

Seam internal side of the right legging (Fig. 5): material natural grey wool, 2-ply yarn; spin direction: Z-twist; fabric: simple seam

Ribbon on the left legging (inferior part: cm 30x1,5 cm – Fig. 6A): material natural grey wool, single yarn; spin direction: S-twist; fabric: made of 12 double interlaced threads

Ribbon on the left legging (superior part: cm 20,5x1,5 cm – Fig. 6B); material: natural brown wool, single yarn; spin direction: S-twist; fabric: made of 12 double interlaced threads

Seams of the ribbon on the left legging (Fig. 4D); material: natural grey wool, 2-ply yarn; spin direction: Z-twist; fabric: simple seam

Ribbon on the lower edge of the left legging (Fig. 4C); material: natural grey wool, 2-ply yarn; spin direction: S-twist; fabric: made of 5 double threads

Seams of the ribbon on the lower edge of the left legging (Fig. 4C); material natural grey wool, 2-ply yarn; spin direction: Z-twist; fabric: simple seam

Strings made of 5 interlaced wool threads, with Z-twist are inserted to keep the leggings firmly in place (Fig. 4A-B).

The over-leggings

The second pair of leggings (about 55 cm long, 16 cm large and with a circumference of about 34 cm) is made of a heavier textile in a weaving technique which could be classified as herringbone twill (Fig. 7). The current colour varies from a light brown-grey to a heavy brown-red; a complicated chromatic effect simply produced by a change of bobbin during the weaving process. We can also see an obvious patch on the left knee (Fig. 8), made of a piece of thin tabby, which does not seem to be similar to the other samples. Two short flaps, which stick out frontally, are visible on this pair of leggings, too. In the lower part of the legging thin cords are inserted across the textile to keep the leggings held firmly to the heel and the big toe. The lower part of these two pieces of cloth shows intermittent reinforcements and darns.

Over-leggings in 2/2 twill: technical details

Warp material: natural beige wool, 2-ply yarn; spin direction: Z-twist; density of the fabric: 8 per cm

Weft material: natural light brown to dark brown wool, single yarn; spin direction: S-twist; density of the fabric: 7 (double yarn) per cm

Seams on the over-leggings (Fig. 7 B,D); material: natural beige wool, 2-ply yarn; spin direction: Z-twist; fabric: simple seam

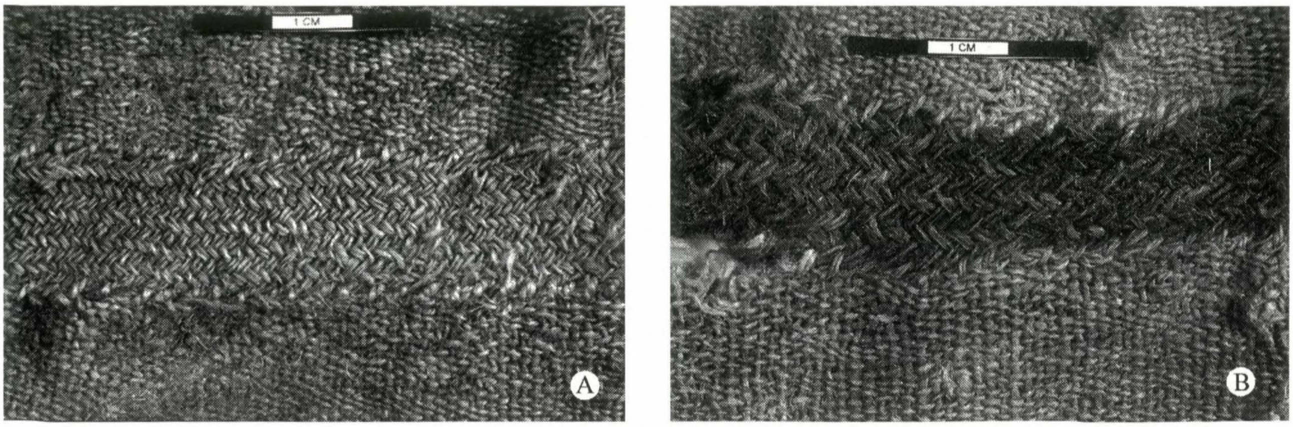


Fig. 6: Ribbon on the inner side of the left legging: 6A: lower extremity of the ribbon, natural grey coloured. – 6B: upper extremity of the ribbon, natural brown coloured (© M. Samadelli, South Tyrol Museum of Archaeology, Bozen).

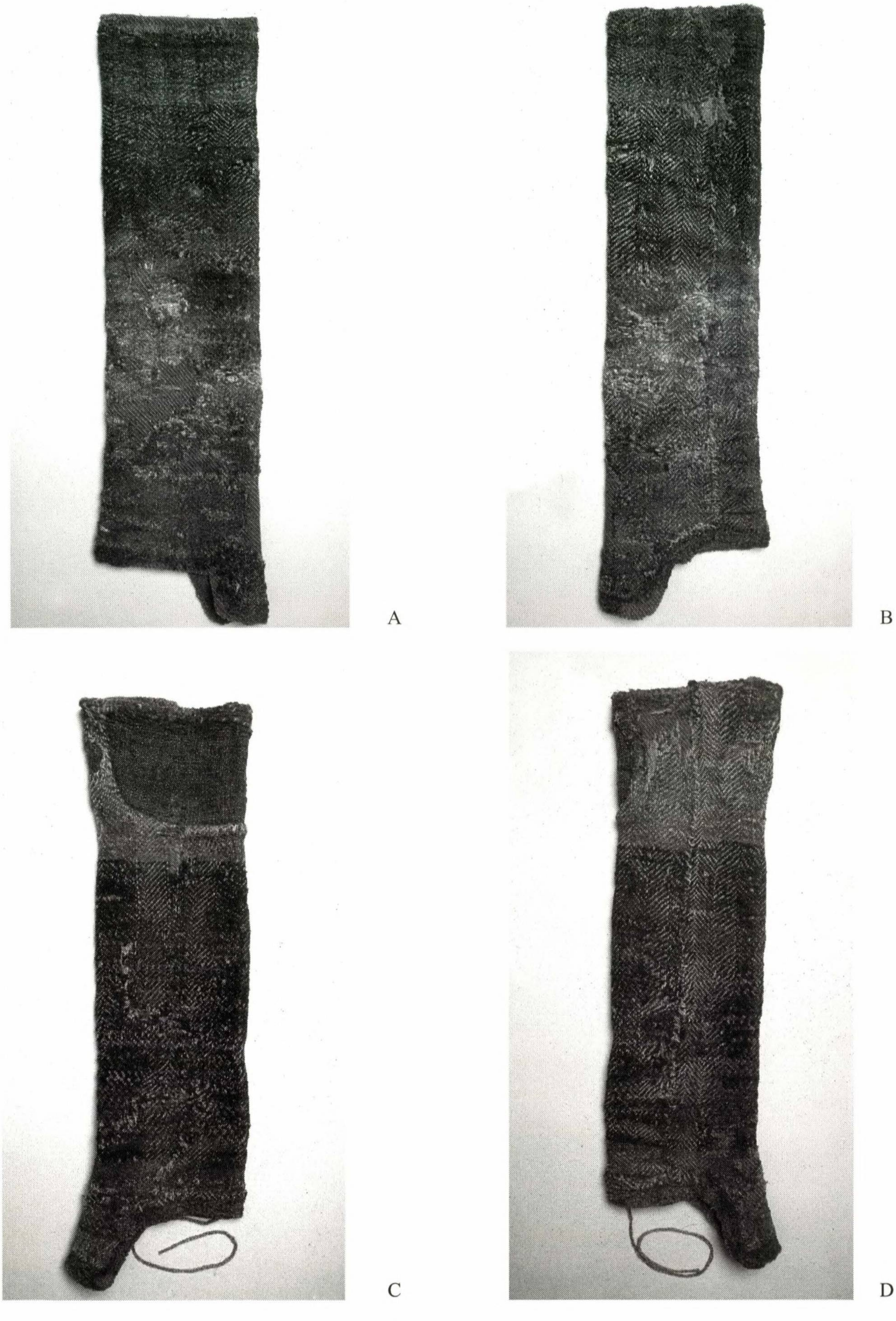


Fig. 7: The over-leggings in herringbone twill: 7A: the outer side of the right legging. – 7B: the inner side of the right legging. – 7C: the outer side of the left legging. – 7D: the inner side of the left legging (© M. Samadelli, South Tyrol Museum of Archaeology, Bozen).

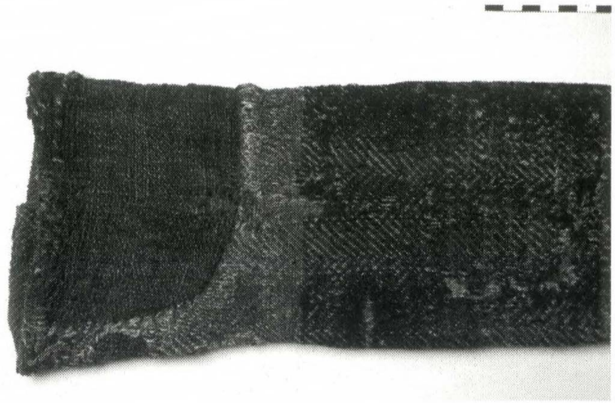


Fig. 8: Patch on the upper extremity of the outer side of the left legging (© M. Samadelli, South Tyrol Museum of Archaeology, Bozen).

Cords made of 5 interlaced 2-ply wool threads with Z-spin direction are inserted to keep the leggings firmly in place (Fig. 7C-D)

Patch on the upper part of the left over-legging in tabby (9,5x16 cm - Fig. 8)
Warp material: natural brown wool, single yarn; spin direction: Z-twist; density of the fabric: 9 per cm
Weft material: natural brown wool, single yarn; spin direction: Z-twist; density of the fabric: 6 per cm
Seams of the patch; material: natural brown wool, 2-ply wool yarn; spin direction: Z-twist; fabric: simple seam

The inner shoes

One of the two inner shoes (Fig. 9) was found in good condition; the second sample, however, was in a very bad state of preservation. In both cases the inner shoes are of thin textile made in 2/2 twill. On the better preserved sample (about 30 cm long, 11 cm wide and 20 cm high) it is possible to see that the inner shoe, including the sole, was made of ten separate pieces of material, sewn together and roughly wrapped (Fig. 11). The separate pieces were sewn together using 2-ply brown woollen thread with the sides of the pieces overlapping by approximately 0.5 cm.
The inside and outside surfaces are felted and where the textile is worn-out the colour appears lighter and the weft and warp can be seen. The narrow textile cords (8-10 mm in breadth) in tabby were attached to the ankle (Fig. 10).
Two patches of grey-coloured woollen material were sewn to the inside of the inner shoes to strengthen the soles, while two dark brown-black patches were added to protect the pointed toes and heels of the shoes. Both shoes are essentially very similar in shape and appearance although their component parts differ somewhat. General wear-and-tear has caused them to lose much of their original shape.

Inner shoes in 2/2 S twill: technical details

Warp material: beige-brown wool, single yarn; spin direction: strong Z-twist; density of the fabric: 12 per cm
Weft material: beige-grey wool, single yarn; spin direction: S-twist; density of the fabric: 8 per cm

Patch (in two pieces) to strengthen the sole in 2/2 S twill
Warp material: grey wool, single yarn; spin direction: Z-twist; density of the fabric: 10 per cm
Weft material: grey wool, single yarn; spin direction: Z-twist; density of the fabric: 8 per cm
Seam of the first sole patch, material: light to dark brown wool, 2 ply yarn; spin direction: Z-twist (of two S-spun yarns); fabric: simple seam
Seam of the second sole patch, material: light to dark brown wool, 2-ply yarn (used double); spin direction: Z-twist; fabric: simple seam

Patches to strengthen the point and the heel of the shoe, in 2/2 S twill
Warp material: dark brown wool, single yarn; spin direction: Z-twist; density of the fabric: 8 per cm
Weft material: dark brown wool, single yarn; spin direction: Z-twist; density of the fabric: 6 per cm
Seams of the patch on the point material: light beige wool, 2-ply yarn; spin direction: Z-twist (of two S-spun yarns); fabric: simple seam
Seams of the patch on the heel material: blue 2-ply wool thread; spin direction: Z-twist (of two S-spun yarns); fabric: simple seam

Cord in tabby (8-10 mm in breadth)
Warp material: dark brown 2-ply wool yarn; spin direction: Z-twist (of two S-spun yarns); density of the fabric: 20-22 per cm
Weft material: dark brown wool, 2-ply yarn; spin direction: Z-twist (of two S-spun yarns); density of the fabric: 6 per cm

Additional finds

There are various wool ribbons and cord fragments that probably belonged to the clothing and / or footwear, although these cannot be precisely attributable to any single garment.

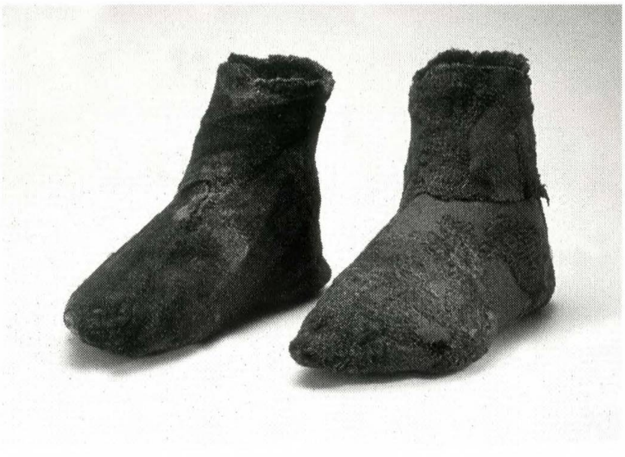
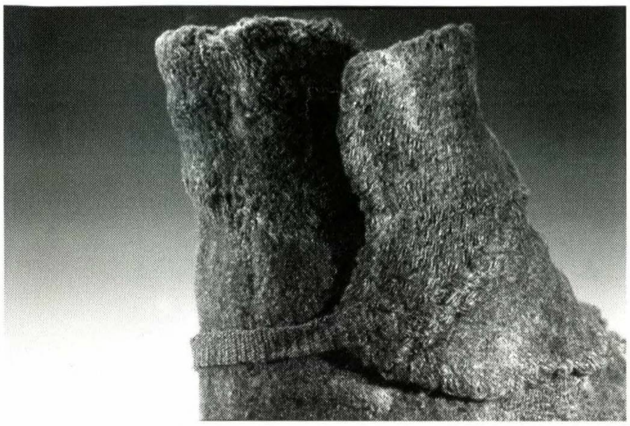


Fig. 9: The two inner shoes in tabby (© M. Samadelli, South Tyrol Museum of Archaeology, Bozen).



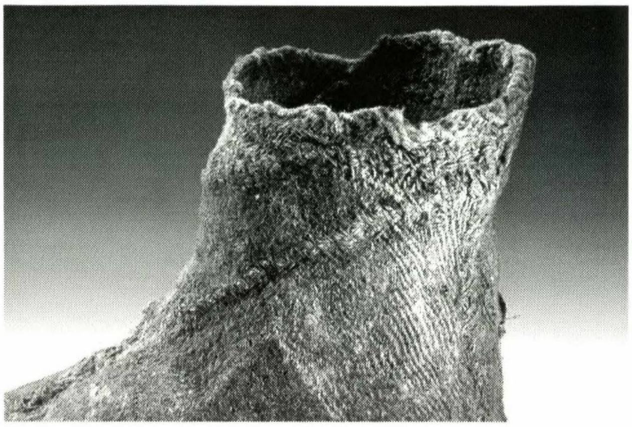


Fig. 10: (left) Inner shoe with string (© M. Samadelli, South Tyrol Museum of Archaeology, Bozen).
Fig. 11: (right) The inner shoe, with detail of the seams (© M. Samadelli, South Tyrol Museum of Archaeology, Bozen).

There are two larger fragments and a series of smaller fragments of tanned skin including preserved seams, and hemmed borders that are identified by following the alignment of the seam holes. These are parts of a piece of leather footwear (Fig. 13).

The analysis of the leather finds[3] attributed most of the hide parts to the species *Capra*. Some of the laces are however attributed to ox-leather and an immunological test confirmed this hypothesis.

There is a total absence of vegetable material. The textile is made completely of wool and there are leather remains, which are sewn with thin skin strips that are sometimes mixed with wool thread or with a different material of animal origin such as tendons or intestines[4].

The textile fibres

The textile fibre identification attested the use of goats' wool[5]. Among the samples examined, there was no evidence for the use of fibre of a different nature, nor of hairs of other mammals. However, among the Riesenferner finds of ox-leather, there is a possibility that the hairs of ox were used as a resource. The fibre used in the Riesenferner finds come from animals that were clearly well supplied with rigid and strongly pigmented hairs.

Different qualities of textile fibre have been used in the production of the artefacts. This was surely an intentional process. The raw hair fibres were destined for the production of threads for seams[6] or in those cloths which did not need to be soft. The weft of the over-leggings, in herringbone twill, were woven in coarse and rough wool, while the threads of the under-leggings in tabby weave are made of a lighter and thinner, soft and homogeneous wool. The warp of the over-leggings is made of light and thin fibres and on this occasion the choice was probably for technical reasons. The warp threads need to be resistant[7], since they are exposed to the greatest wear.

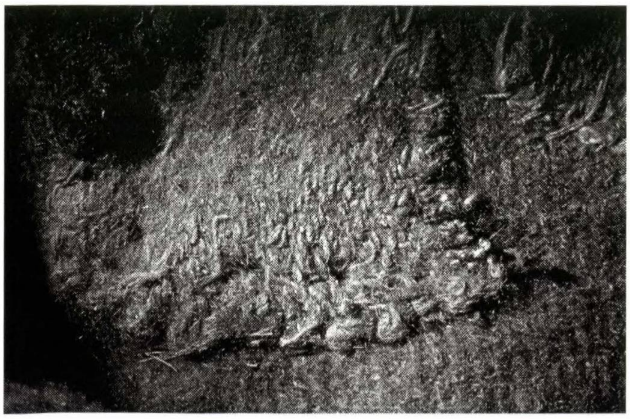


Fig. 12: Reinforcement on the left inner shoe by the heel, sewn with a blue coloured thread (© M. Samadelli, South Tyrol Museum of Archaeology, Bozen).

Dyeing

Traces of dye are only visible on the thread that was used for the seam of the reinforcement patch on the sole of the left shoe (Fig. 12).

By careful observation with the naked eye, the colour is also evident and preserved in a particularly protected area.

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[3] Conducted by Cristina Cattaneo, E.L.I.S.A. (enzyme linked immuno sorbent assay), for the Museum in Como.

[4] The analysis of the seam threads was conducted by Antonella Lazzaro for the Museum in Como.

[5] The analysis was conducted by Alfio Maspero, who unfortunately died before he could publish his final results. It is not yet clear if all the Riesenferner wool fibres are goats` wool (Maspero 1995-96). The manuscript that he left seems to confirm this hypothesis. Some other analyses will be made in the future.

[6] Most of the leather seam threads are made of small, leather strips or in other material of animal origin, (tendons, intestines?). Some of the skin threads are associated with thread of spun animal hairs, maybe the same material as in the main part of the cloth.

[7] The coarse hairs of sheep and goats have a reduced cortex and an extremely expanded medulla. The wools elasticity is due to the external layers, while the medulla its rigid and tends to break. The overhairs are also big and delicate, contrastingly the underhairs are thin and resistant, almost totally lacking medulla (Ryder 1983).

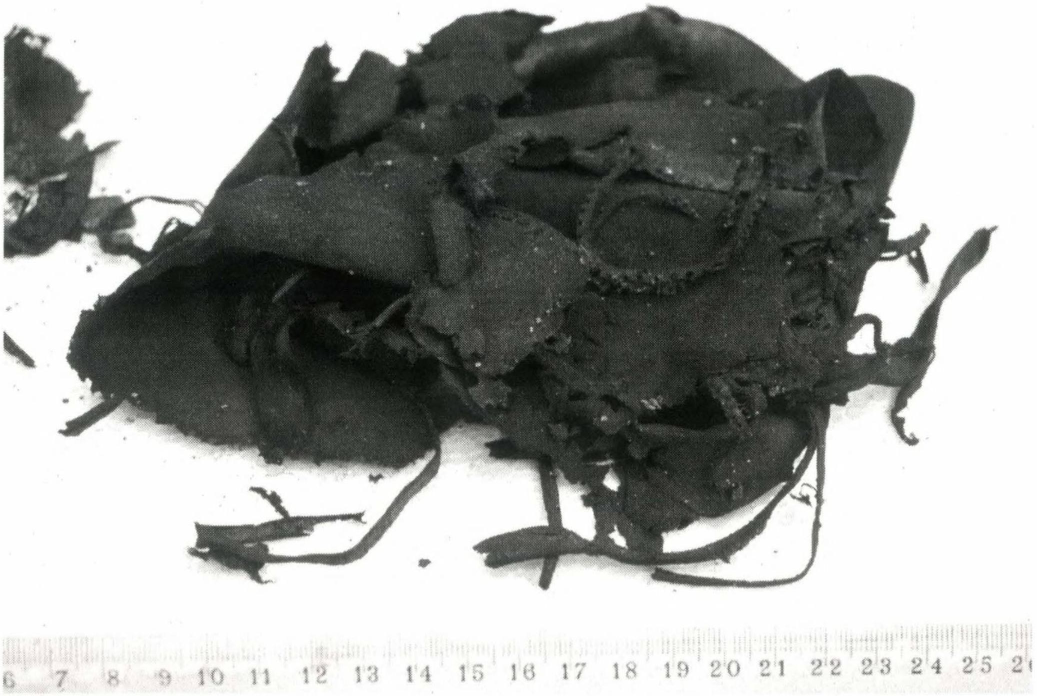

Fig. 13: Leather finds (© M. Samadelli, South Tyrol Museum of Archaeology, Bozen).

The rest of the colouring of the textiles has probably been washed away[8]. Chemical analysis has identified indigo as the dyestuff.

However, it is not possible to distinguish between the colouring molecule of the indigo plant and that of *Isatis tinctoria* L. (woad), the traditional plant from which indigo colour was extracted in Europe. It seems highly probable that the dye was obtained from this latter plant.

Interpretation

In the Riesenferner finds we find ourselves confronted by clothing elements of a male individual. The shape and size of the two pairs of leggings are more or less the same. In relation to their function, the first pair of leggings (the under-leggings) has been interpreted as a variety of "socks" to wear directly next to the skin. The second pair (the over-leggings) is instead a type of "trousers" to wear over the first pair. It is probable that two garments of the same type, manufactured with textiles of different weight, were worn at the same time to secure better protection against the cold. The double layer of wool textile, which covered the legs and the complicated structure of the footwear (leather outer-shoes and wool inner shoe) suggest high mountain equipment, suitable for the late spring or the early autumn. There does, however, seem to be a certain contradiction between the elaborate technique of the textiles, especially in relation to the over-leggings and the presence of many darns and patches.

In both samples, the under-leggings show contrasting manufacture, and despite the textile likeness, they appear not to be matching fabrics. The same could be observed for the over-leggings: if the weaving technique is the same, the difference is undoubtedly in the manufacturing density. All of these observations increase the sense of second-hand dress or the reuse of clothes of some value. The large number of darns and repairs seem to reflect people who were forced to live in isolated contexts for long periods of the year.

The weaving technique on the textiles of the Riesenferner group shows the use of herringbone twill. This is also fully documented in the salt mines of the Eastern Alps (Hallstatt and Dürrnberg)[9] and well attested in the Etruscan World (for example, the late Villanovan tomb of the VII-VI century at Furbara near Rome and in the Tomba di Verucchio, Ravenna)[10].

The diffusion of twill, with the heddle-loom, shows the great innovation in weaving techniques during the Early Iron Age[11]. This kind of production has its predecessors in the Early Bronze Age, as demonstrated by a decorated item found in the lake-dwelling of Molina di Ledro (TN)[12].

More significant perhaps is the contribution of the Riesenferner textiles to the history of fashion. We have relatively good evidence on this subject for males and females in the Bronze Age, but information for the Iron Age is considerably more sparse.

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[8] The analysis showed that among the wool there are occasional fibres in light-blue colour.

[9] Hundt 1959, 1960, 1961, 1967, 1987. – Barth 1990.

[10] Bonfante 1975. – Stauffer 2002.

[11] Hoffman 1964. – Sailer-Baldinger 1991.

[12] Perini 1970. – Bazzanella, Belli, Mayr 2003.

The first attempt to reconstruct a male outfit of the Iron Age was by Hans-Jürgen Hundt in the 1960's, essentially based on the iconography of the well-known scarbbard from Hallstatt tomb 994 which is dated to the end of the V century B.C. Based on this representation, Hundt considered that strips or "puttees" were used to cover the legs[13]. Otto Hermann Frey however in 1991 interpreted the garment of the Hallstatt scabbard as fabric trousers that were variously decorated. The Similaun finds, which are 2.500 years older, would confirm this second interpretation[14].

Regarding actual finds of leg wrappings or leggings in the Iron Age, we have the Søgaard Mose example in Denmark[15], Knee wrappings at Obenaltendorf and leg wrappings at Bernuthfiled, both in North Germany[16].

As to the inner-shoes, there are strong similarities with a find from the Bronze Age Guldøj tomb in Denmark. Textile foot wrappings of simple, approximately rectangular shape like those for example from the Skrydstrup burial in Denmark[17], belong by contrast to a different type of clothing. For the Iron Age, similarities can be seen with the textile find of Padova – Largo Europa[18].

The leather shoes can be classified as footwear in which the vamp and sole are formed by a single piece of leather: the very regular sewing holes along the sole margin are proof at this. This kind of shoe falls into the ethnographic category of the so-called "saalsko". Analogous artifacts are attested, for example, in the Danish bog finds of Søgaard Mose and Franer Mose[19]. However, the fragmentary condition of the leather prevents the reconstruction of important relevant details, especially the shape of the toe of the shoe.

The findspot is within the cultural influence of the Pusteria valley and is on one of the more important trade routes of the Alps. In the Hallstatt period, this represented a primary thorough-fare artery for the diffusion of many types of cultural acquisition.

In terms of the settlement history of the two territories connected by the Gemsbichljoch, that is to say from the Rain and Antholz valleys, it is likely that the absence of finds is only a reflect of a gap in research. In the valleys, but especially in the second one (Antholz), there may have existed a different type of Iron Age settlement. The Riesenferner traveller probably originated here. A series of isolated finds (a fibula from Antholz, a lance tip from Tures, a bronze axe from Sand am Taufers and another one from Ahornach (Sand in Taufers)[20]), suggest that there may have been a network of permanent settlements within a reasonably short distance of each other. The identification of a system of Iron Age settlements in this area is really only a question of time.

In the current state of research there is only one well-known settlement of the Iron Age, the Windschnur burial near Niederrasen, at the bottom of the Pusteria valley[21]. The distance is certainly modest, 4-5 hours walk from Riesenferner, and furthermore, in the Windschnur burials recent finds[22] include typical equipment and tools for use in the high mountains, such as metal crampon footwear.

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[13] Hundt 1970.

[14] Goedecker-Ciolek 1993.

[15] Hald 1980.

[16] Hahne 1920.

[17] Hald 1972.

[18] It is a woollen textile, which covered a left human foot. It is composed of sections of cloth, roughly wrapped, and of two pairs of strings to keep the textile held firmly to the foot (Maspero, manuscript).

[19] Hald 1972.

[20] Lunz 1997A. – Tecchiati 1994.

[21] Lunz 1997B.

[22] Demetz 1997.

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Curricula vitae

Marta Bazzanella studied prehistory at the University of Trento in Italy and at the University of Geneva in Switzerland. Since 1990, she has been a freelance researcher and has worked for the Natural History Museum in Trento, the Institute of Prehistory of the University in Trento, for the Ufficio Beni Archeologici (Cultural Heritage) in Trento and for the Ufficio Beni Archeologici (Cutural Heritage) in Bolzano/Bozen. Her main interest lies in prehistoric textiles, textile technology and the prehistoric bone industry. Since 2003 she has worked for the Folklife Museum of Trentino.

Lorenzo Dal Rì studied at the Ancient Literature Department of the University of Padua, where he graduated in 1971 with a thesis about prehistoric mines in Trentino-South Tyrol. Since 1974 he has been inspector at the Soprintendenza ai Beni Culturali of Bolzano/Bozen. He is director of the Ufficio Beni archeologici (Cultural Heritage) of South Tyrol. From 1997 to 1999 he was also director of the South Tyrol Museum of Archaeology. He has a great interest in ancient milling.

Alfio Maspero was born on the 25.12.1962 in Cantù and died suddenly the 08.06.2002 from an heart attack. He studied natural science at the University of Milano and graduated with Professor Mauro Cremaschi. After 1983 he worked at the "P. Giovio" Museum of Como, where he was one of the members of the laboratory of archeobiology: one of the most important laboratories in Italy for the study of paleobotanical and organic remains. Among his works one may mention the analysis conducted on the textiles and on the wood of the Longobard burials of Castelli Calepio (BG) and of Cividale del Friuli (UD), the analysis of the textiles of Uan Afuda in Libya and of Riesenferner in South Tyrol (BZ).

Irene Tomedi studied at the Art School of St. Ulrich in Gröden. From 1979-1982 she attended a course for restoration of ancient textiles, conducted by Dr. Mechtild Flury-Lemberg at the Abegg-Stiftung in Bern, where she then worked as assistant for two years. Since 1984 she has had her own workshop in Bozen and has worked for the Cultural Heritage of Venezia, Milano, Roma, Bozen, Trento, Caltanisetta, Turin and Innsbruck.

More than old rags
Textiles from the Iron Age Salt-mine at the Dürrnberg[*]

Thomas Stöllner

Abstract

In the frame of archaeological mining research an extended complex of Iron Age textiles has been discovered underground in the Celtic salt-mining complex at the Dürrnberg near Hallein, Austria, since 1990. Most of the fabrics are recorded as rags and pieces – most of them may have come in a secondary or in even their last use into the mines. Miners' clothes can be recognized only rarely. In comparison with Hallstatt more simple weaving and spinning patterns were dominating but in contrast more than one quarter of all fabrics were made of hemp/flax, partly as very fine weaves. On the basis of recent research the state of knowledge is discussed with a view on archaeological context and find situation, on weaving, on dyes as well as on fibres.

Im Zuge der montanarchäologischen Forschungsarbeiten zum keltischen Salzbergbau im Salzberg von Dürrnberg bei Hallein, Österreich, wurden seit 1990 umfangreiche Bestände eisenzeitlicher Textilien geborgen. Die Textilien umfassen meistenteils Fetzen und Stücke, die in Endverwendung in die Gruben gekommen sind. Nur selten sind Reste eigentlicher bergmännischer Kleidung zu erkennen. Im Vergleich zu Hallstatt überwiegen einfachere Web- und Spinnmuster, dagegen ist zu einem Viertel der Fälle Flachs/Hanf als Faserstoff nachgewiesen. Der Forschungsstand zu den Dürrnberger Textilien wird auf Basis bisheriger Untersuchungen in Hinblick auf Fundlage und archäologischen Zusammenhang, auf Webtechnik, Farb- und Faserstoffe dargestellt.

Introduction

The Dürrnberg can be considered as one of the most important Iron Age sites of Central Europe. The area is situated ca. 15 km south of Salzburg in middle-range highlands, part of the Northern Calcareous Alps. The Alpine salt deposits of the Dürrnberg – largely responsible for the special topographic conditions of the area – are mostly Permian in age and represent sediments laid down in a marine basin surrounded by alluvial fans and mudflats in a rift arm of the Tethys Ocean. In parts these layers were shifted northwards and forced upwards by tectonic movements in the course of the formation of the Alpine anticlines[1].

In parts these salt containing layers, now called "*Haselgebirge*", were pressed upwards to a degree that they became reachable for early exploitation. This situation attracted man from the Neolithic periods on to use the salty springs and later on also the salt deposit by underground mining (Fig. 1). Especially between the 6th and the 1st century BC the Dürrnberg was one of the leading salt-producers in southern central Europe – a large economic centre and market developed during that time[2]. The richness of archaeological monuments still preserved has attracted scholars for nearly a century. The outstanding survival of rich burial grounds, of settlements and production areas like the salt-mine as well as of the wide range of organic material preserved by salt or by waterlogged conditions presents a complete and panoramic picture of the economic life of a complex society over a period of more than 500 years.

Textiles are among the most important artefacts found during many years of underground research in the Dürrnberg salt-mine[3]. During that time nearly 600 complexes of textiles have been excavated at the different underground mines. They give a strong impression of textiles as fundamental materials in the Early Iron Age – it seems at least to be one of the largest complexes from the European Iron Age[4]. According to our chronological studies the dating of the fabrics ranges between the 6th and the 3rd and 2nd centuries BC – but it turns out that most of them date to the Late Hallstatt and the Early La Tène Period, especially to the 5th and 4th century BC.

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[*] The conference and the publication could not be attended by the colleagues who are actually are working on Dürrnberg fabrics, particularly K. v. Kurzynski, M.A., Marburg, in the frame of her PhD-work. M. L. Ryder, Southampton (analysis of wools and fibres), J. Wouters, Brussels (analyses of dyestuffs) and G. Bonani, Zurich (AMS-^{14}C-dating). For their work all these colleagues are gratefully recognised and thanked. A final publication must await the completion of K v. Kurzynski`s PD-thesis.

[1] Schauberger 1986. – Gawlick and Lein 2000.

[2] Recently summarizing: Zeller 1995. – Stöllner et al. 2003.

[3] Klose 1926. – Hundt 1961. – Kurzynski 1996 and 2003.

[4] Compare Bender Jørgensen 1992. – Kurzynski 1996. – Banck-Burgess 1999.

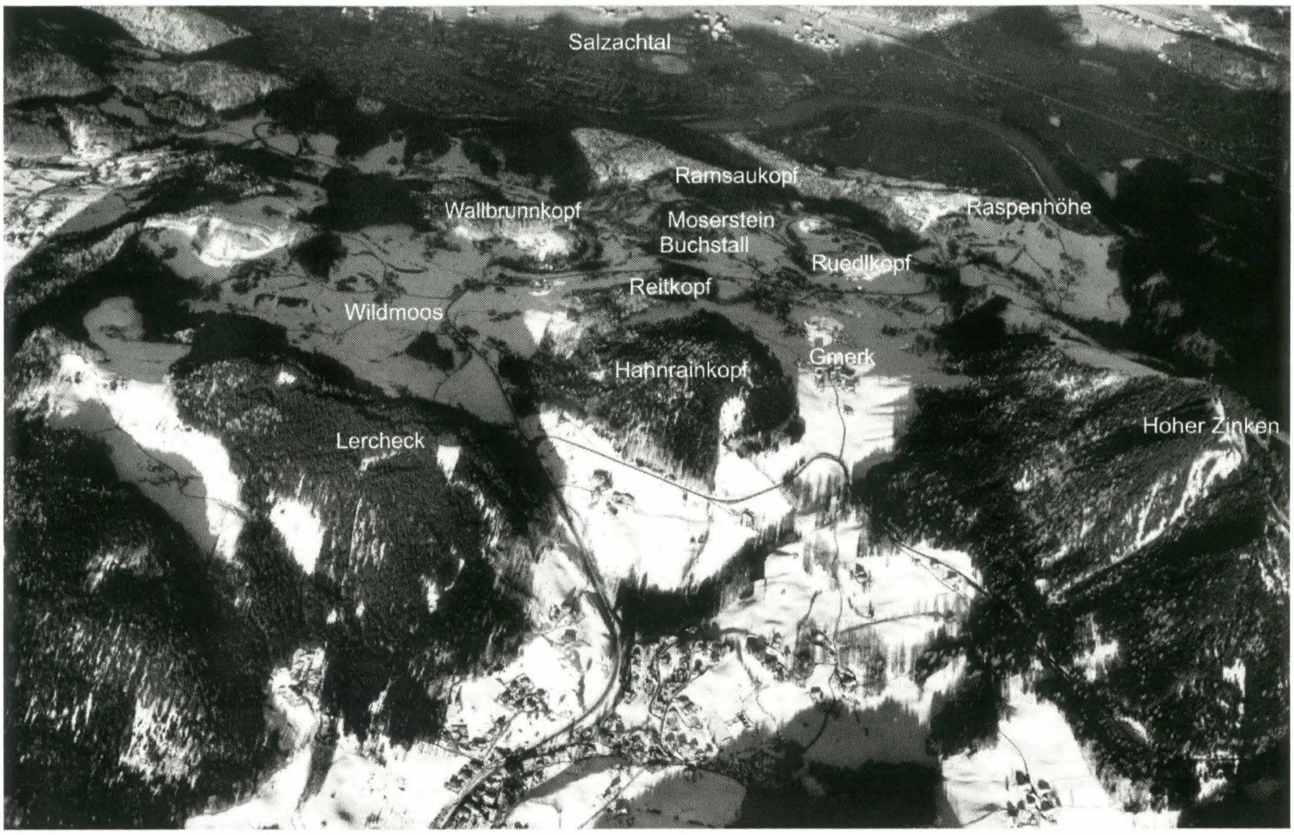

Fig. 1: The Dürrnberg with its salt deposit dominated by the Hahnrainkopf (height: 1.026 m) and other important topographical landmarks from West (Foto: © Bayer. Landesamt f. Denkmalpfl., Archive-Nr 8344/004, SW 3453-12, O. Braasch).

The large number of fabrics in the mining waste is remarkable. This prompts us to ask about the production mode of textiles in the Dürrnberg community. Generally it seems clear that fabrics were produced on the Dürrnberg, but it is still a matter of discussion, whether they were made by a group of craftspersons, who worked in an industrial mode, or whether textile production was still bound to the household units. This question is raised particularly by obvious differences between the older textile-complexes of Hallstatt and those of the Dürrnberg[5]. In Hallstatt individual patterns and weaving techniques dominate while at the Dürrnberg more standardised fabrics are known. As the textiles at Hallstatt are generally earlier in date compared with those of the Dürrnberg, these differences may reflect remarkable economic changes between the periods represented by the two salt-mining sites.

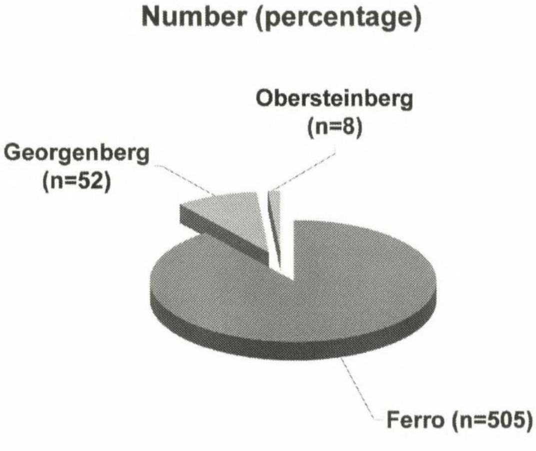

Fig. 2: Percentage of textiles found in three of the prehistoric mines at the Dürrnberg (excavations 1990-2000) (© Th. Stöllner).

The archaeological context of textiles at the Dürrnberg

Most of the fabrics are discovered in the so called "*Heidengebirge*", secondary rock-salt debris compressed together with waste of the production process by continuous tectonic pressure within the salt deposit[6]. These layers completely fill up the old galleries. Their stratigraphies reflect the changing fortunes of ancient salt-mining. If mining was exploiting successfully rich rock-salt layers, the debris generally contains more small fragments of salt than when poorer clay-containing strata were worked. In some cases inundations of mud filled the open underground spaces.

They reflect catastrophes like floods after heavy rain showers, mainly in summer, or even mud slides – avalanches

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[5] Kurzynski 1996: 33-36.

[6] Recently Stöllner 2002/2003: esp. 45-49.

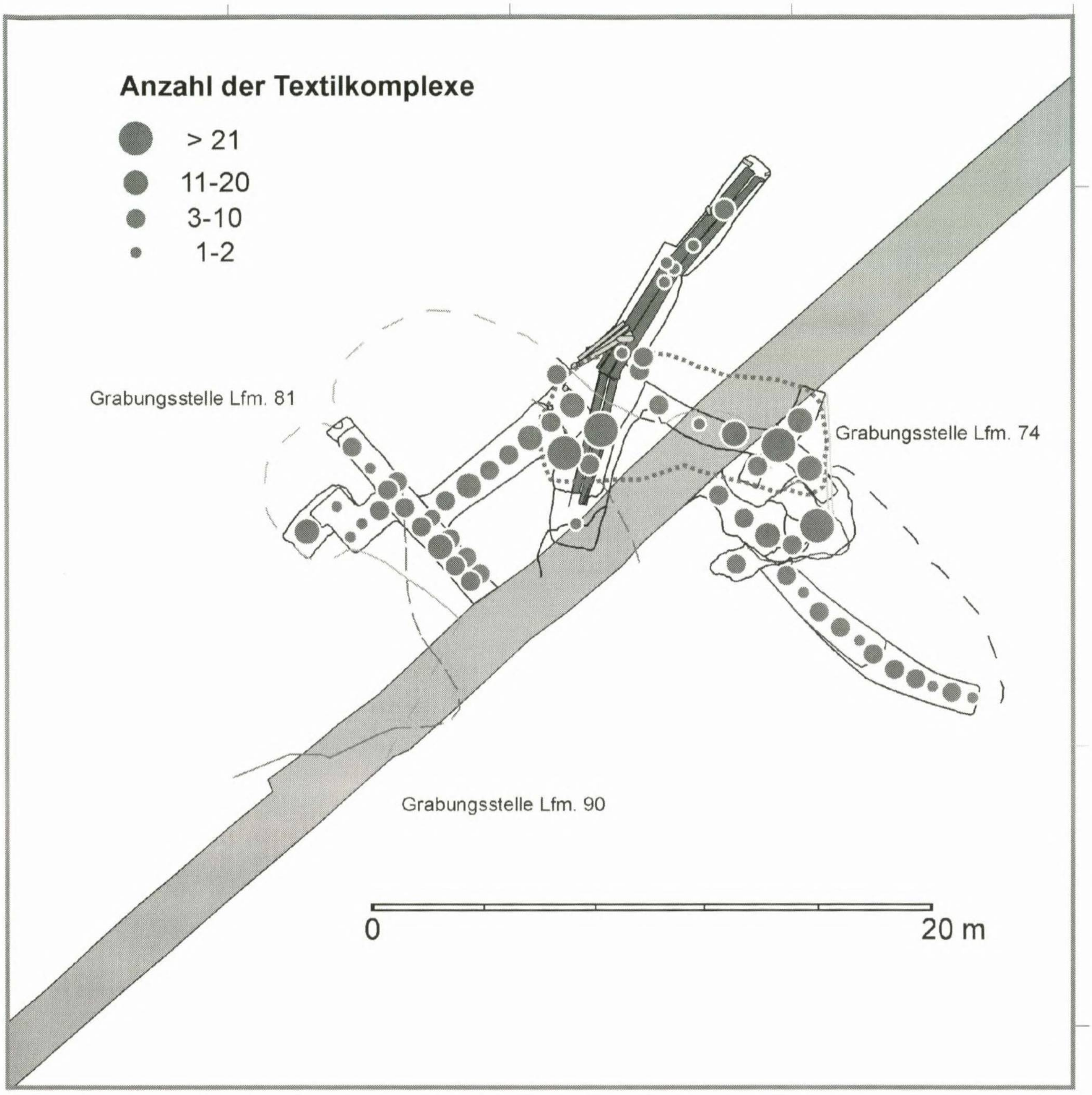

Fig. 3: Distribution of textile assemblages per numbers in the Ferro-Schachtricht excavation, Late Hallstatt to Early La Tène period. The dotted line marks the prehistoric waste dump mentioned in the text (© Th. Stöllner).

that really could lead to a collapse of mining work. Such contexts are nearly free of archaeological debris and only by chance do textiles derive from such layers.

As the mining of rock salt took much more working effort and time, generally organic waste like wooden handles and working equipment, excreta or textiles are much more numerous in salty debris attributed to this type of exploitation. This special debris is called "*kerniges Heidengebirge*", the a so called "*Old man-layer*" or a "*pagan-rock layer*" that is nearly as hard as a rock salt-layer (therefore called a "*Gebirge*").

Due to the high degree of salt penetration all organic material is preserved in a fascinating and unique way – even colours still look like they were in their original stage. Considering the hard state of those layers and their salty consistency archaeologists have to use mine worker's techniques to conduct an excavation[7]. Most of the time we use pneumatic drills to dig the pagan-rock layers – sometimes we have been successful in using a sieving system underground. Advancing the excavation-galleries by wet leaching generally had positive effects as the pneumatic drilling work led to serious damages for the archaeological artefacts. So sometimes we could observe that textile material was cut up by advancing the galleries with the help of a pneumatic drill. We looked systematically for smaller remnants by washing the salt-bearing archaeological de-

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[7] Stöllner 2002/2003: esp. 24-34.

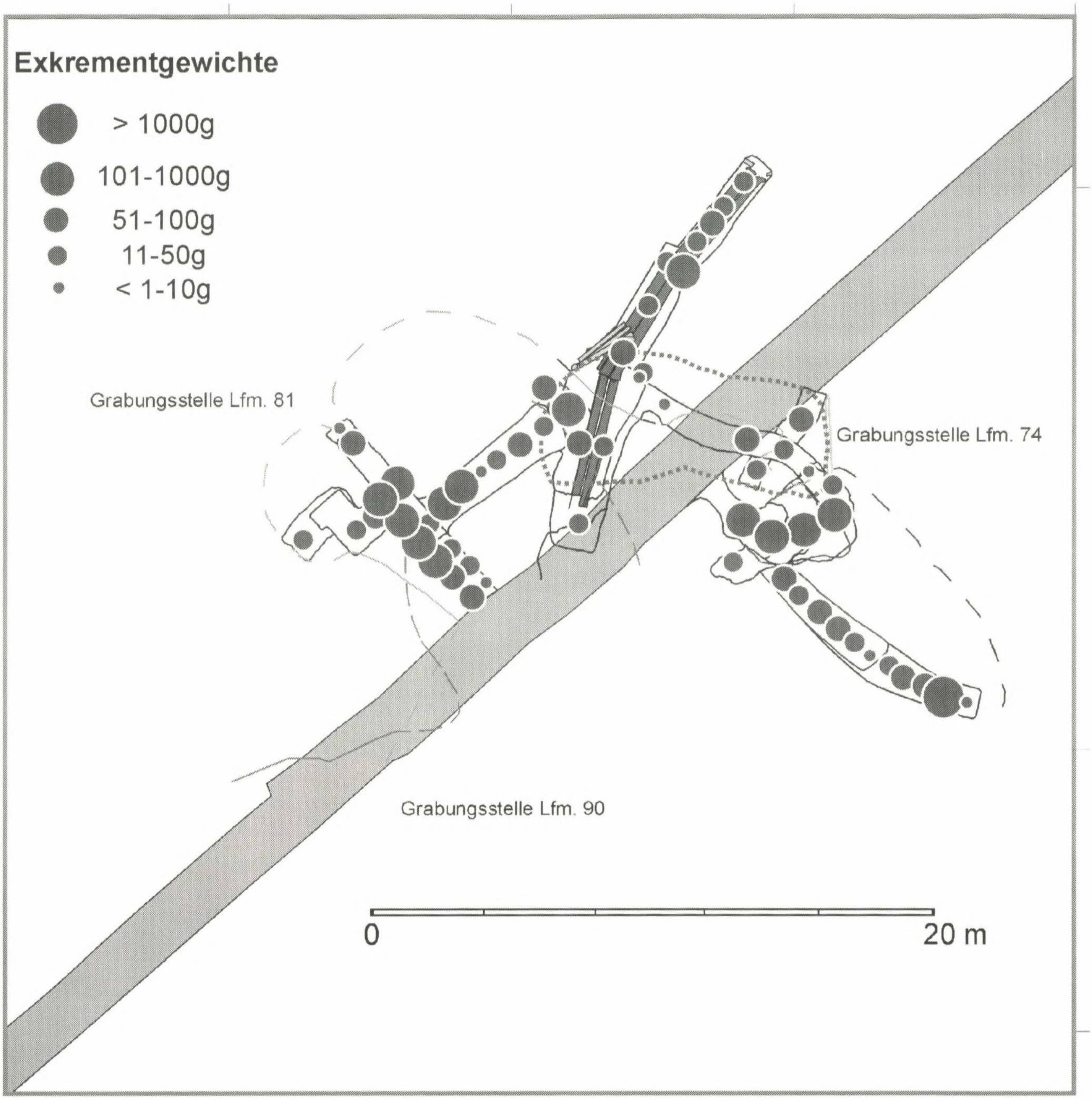

Fig. 4: Distribution of human faeces (excrement) per weight in the Ferro-Schachtricht excavation, Late Hallstatt to Early La Tène period. The dotted line marks the prehistoric waste dump mentioned in the text (© Th. Stöllner).

bris on a sieving station – so, as a consequence different artefact numbers were used for some of the fabrics according to their provenance from the excavation gallery or from a sieving sample[8].

As a result of our constant sieving – which in fact could not been done for all the archaeological layers – even the smallest rags have been found. After examination by K. v. Kurzynski we now can count more than 565 textile assemblages – most of them, about 89 %, came from the excavation site at the Ferro-Schachtricht. The mining layers found there can be considered to be probably the oldest and so far also largest mining area from the Iron Age in the Dürrnberg salt deposit[9] (Fig. 2). A system of two overlapping galleries, in fact halls, have been discovered, dating within a range of nearly 200 years during the sixth and the fourth century BC[10]. Both mining-galleries have a length of more than 200 m and have been deformed by subsequent tectonic movement; only their filling with salty pagan rock hindered the final compression. These layers were always remarkably rich in artefacts – this was men-

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[8] Thanks to the examination of K. v. Kurzynski we are able to have a rough idea about pieces belonging together.

[9] All textiles found between 1990 and 2000 are published in Stöllner 2002/2003 with an additional catalogue of all textiles in the second volume by K. v. Kurzynski.

[10] Stöllner 2002/2003: 439-445.

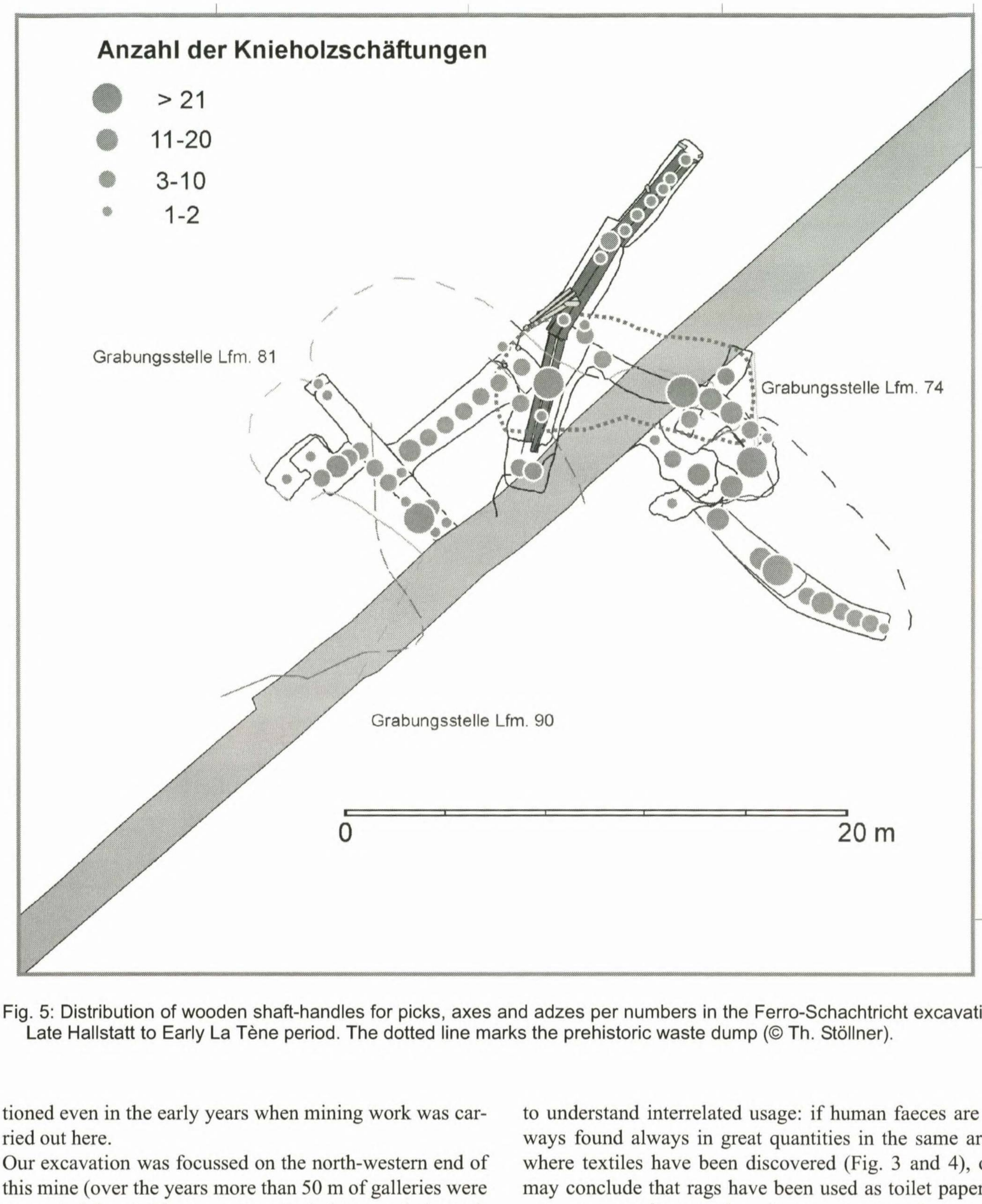

Fig. 5: Distribution of wooden shaft-handles for picks, axes and adzes per numbers in the Ferro-Schachtricht excavation, Late Hallstatt to Early La Tène period. The dotted line marks the prehistoric waste dump (© Th. Stöllner).

tioned even in the early years when mining work was carried out here.

Our excavation was focussed on the north-western end of this mine (over the years more than 50 m of galleries were excavated there). These comparatively large-scale investigations now allow discussion of the special mechanisms whereby fabrics were deposited in the mining debris. Such information may give a glimpse about the textiles' usage in mines. Correlations in locating artefact groups may help us to understand interrelated usage: if human faeces are always found always in great quantities in the same areas where textiles have been discovered (Fig. 3 and 4), one may conclude that rags have been used as toilet paper or even as part of personal sanitary equipment. As we will see below textiles cannot be interpreted as miners' clothes most of the time. It seems more likely that they were already brought as rags to the mines in view of their special preservation and marks of use. Coming back to depositing mechanisms, a general comparison between different artefact groups allows first insights. As the Ferro-Schachtricht has produced textiles and other artefacts in great numbers, it was the only excavation site where reasonable results could be expected[11]; for this investigation we mapped three different groups of finds, all being found in comparable and considerable numbers.

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[11] The other, very extensively excavated site is the so called Georgenberg mine; there we only investigated roughly 8 m of a comparable "*pagan-rock layer*" enriched with small salt pieces and artefacts. Therefore reasonable results comparing with those from the Ferro-Schachtricht were not expectable.

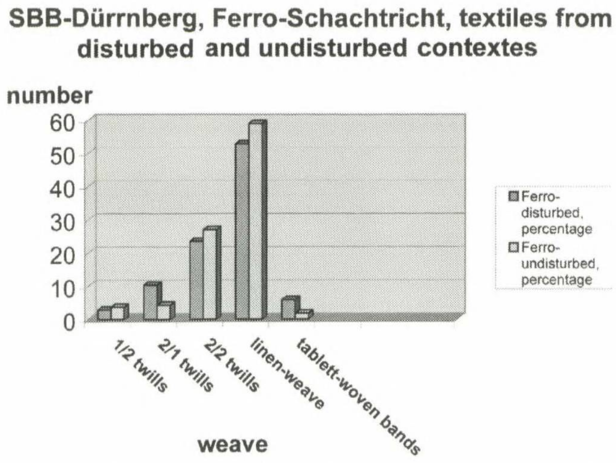

Fig. 6: Weave types from disturbed and undisturbed layers in the Ferro-Schachtricht excavation, Late Hallstatt to Early La Tène period (© Th. Stöllner).

- Textiles only show slight differences in the salt enriched "pagan-rock" that is directly linked with the exploitation of salt. The only remarkable concentration was found in a waste tailing that was dumped in an area connecting both working galleries together. Perhaps this dump can be related with reworking, cooking and repairing of tools (Fig. 3).

- The distribution of human faeces (excreta) confirms that some locations were used as non-permanent latrines; comparing the distribution of excreta-weights with the number of textiles we easily cannot recognize a strong correlation. Especially interesting is the difference to be seen at the waste dump described above. At this waste dump, presumably also a site where people were resting, only a small amount of faeces was discovered. On the other hand the irregular distribution of faeces does not match that of the fabrics. If they were used in a sanitary role then generally they were not used as some kind of toilet paper – even the textile rags may have been too good for that (Fig. 4).

- A better correlation is shown by comparison with the distribution of wooden pick handles. These handles were normally broken in proportion to the hardness of the salt layer being mined, so the great number of tools found in the Ferro-Schachtricht can easily be traced back to the excellent but hard rock-salt layers of this mine. It is not surprising to find them at the working face, consistently sometimes, but more often irregularly distributed. But it is striking to have them in great numbers – like the fabrics – in the waste dump mentioned above. The high number as well as some handles which never have been used but were broken when shafting the iron pick confirm our interpretation: repair work must have taken place there. This underlines the importance of fabrics used as repairing materials for different purposes (Fig. 5).

Observations concerning the build-up of waste in the mining debris underground generally help to explain the numerous textile finds occurring in the mine. They seldom came as parts of clothing actually worn in the mine; it is more likely that textiles were collected as rags above ground. Even today miners often have their bag of rags on a working site – they are useful for many things in daily work.

Dating of the Dürrnberg textiles

As revealed by the stratification in the prehistoric mines most textiles belong to a time span from the Late Hallstatt period to the Middle La Tène period. But as some of the Iron Age mines have been re-opened in later periods (between the 14th and the 17th century) we have to reckon with disturbances[12]. Such disturbances also may cause a mixture of mining waste in some cases and so some criticisms were made of the dating of the Dürrnberg and the Hallstatt textiles[13]. We should add some notes on that point. The most critical point is the recognition of later disturbances in older mining layers – this is especially true in unstructured mining waste consisting mainly of clay or "*Haselgebirge*". In such cases the soft sediments of the salt deposit can close up and consolidate again with hardly any sign of having done so. Fortunately for most of the time later galleries have left working equipment, timbers and occupation layers, detectable by careful observation and excavation. But there are many other criteria that can be used for a relative dating, like type of gallery and exploitation technique. Medieval and modern mining generally leave other traces; for it uses water as a leaching and transporting agent for salt in contrast to the dry rock quarrying of prehistoric miners. But there are also difficult cases where stratigraphical observations are invalidated by particular tectonic movements of layers. In such situations it is best to have a series of dates established by dendrochronology and ^{14}C to get reliable information[14].
Nearly 80 AMS ^{14}C-dates have been established and more than 90 tree-ring samples have produced exact dates[15] – altogether a sound basis for further chronological discussion. As dating of archaeological deposits does not always deliver reliable artefact dating it was reasonable to date in

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[12] Stöllner 2002/2003: esp. 44 f., 118 f., 200-209, 267-274, 381.

[13] Kilb-Werk: Hundt 1960: 127, 150.

[14] Some of the earlier misinterpretation could have been avoided if one had our present experience and plenty of dates.

[15] For more than 10 years dendrochronological investigations have been carried out in the Austrian salt-mining complex by T. Sormaz and U. Ruoff, Labor für Dendrochronologie, Amt für Städtebau, Archäologie und Denkmalpflege, Seefeldstrasse 317, CH-8008 Zürch. The work resulted in an Iron Age mean curve built up from fir (*abies alba*) and Norway spruce (*picea abies*) that comprises the whole Iron Age Exploitation from the late 9th century BC to the late 2nd century BC. More than 150 dates became available that allow many new insights into Iron Age chronology and the economic history of the Eastern Alps. A full publication of the results is planed by the work-group in the near future.

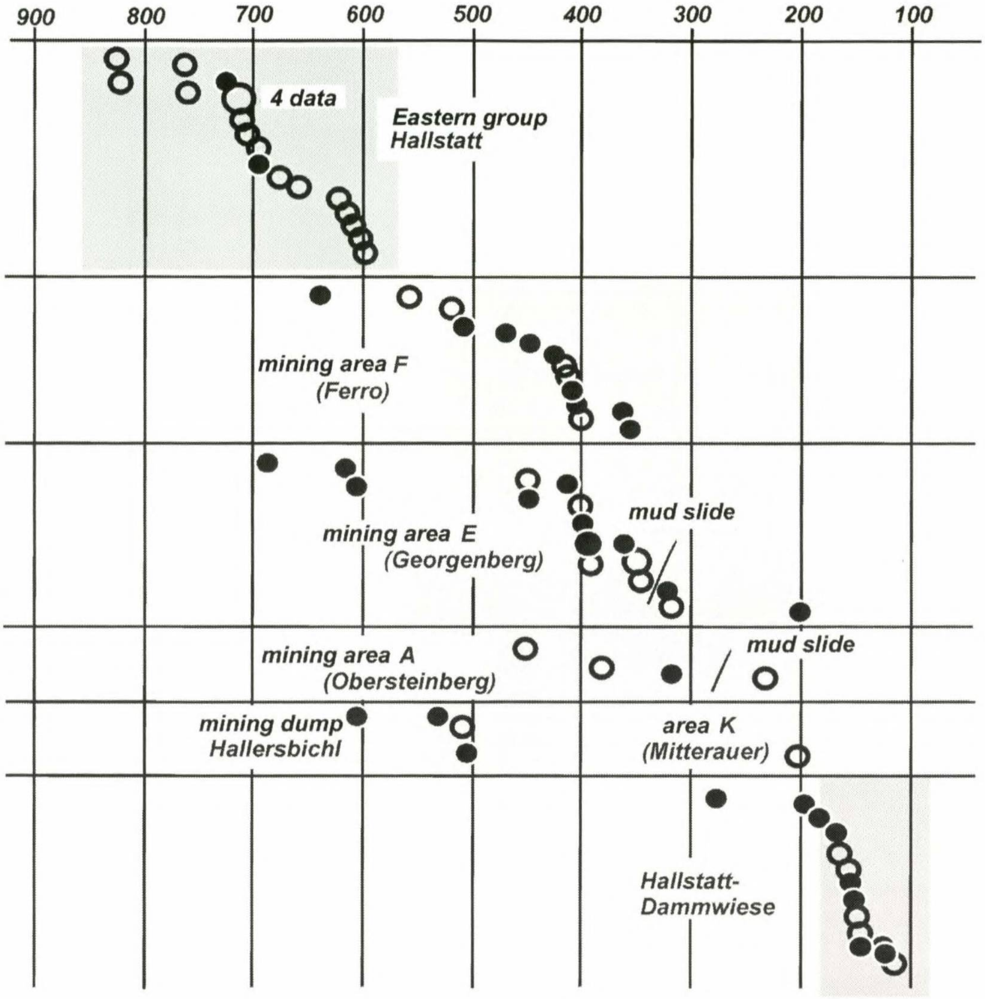

Fig. 7: General chronology on basis of tree-ring chronology of Dürrnberg and Hallstatt, state of investigation: 2004 (after F. E. Barth, M. Grabner, H. Reschreiter, T. Sormaz and Th. Stöllner in preparation).

addition a series of textiles. But in nearly all cases the archaeological dating was confirmed[16]. In some cases later material was detected by weave and fibre type. But dating of the textiles seems unproblematic in the most cases since there are no major differences between disturbed and undisturbed Iron Age layers (Fig. 6): considering possible later pieces it is interesting to find a higher amount of 2/1 twill in disturbed layers of the Ferro-Schachtricht. That possibly points to early modern textiles, but without further dating this is just an open question.

Apart from some dating problems the general picture seems clear nowadays. First of all the Dürrnberg textiles are later than the Hallstatt Eastern group fabrics: this is quite obvious if one compares the tree-ring dates of the Eastern group with those from the Dürrnberg (Fig. 7). This was not always as clear as it is today: earlier scholarship was not able to establish more exact dating for single mining sites in the Eastern group mining complex or the Dürrnberg mines[17]. So it was not clear in detail if fabrics from the two salt-mines should be considered contemporary or different in date. Apart from some Late Bronze Age textiles from the Northern Group and the Tuschwerk most of the Hallstatt textiles come from Eastern group sites that are covered by remnants of a large mud-slide that most probably reduced Hallstatt's salt production for years. However, the Dürrnberg textiles are later and date between the 2nd quarter of the 6th century BC and the 4th century; later mining sites (3rd and 2nd century) are known but they have only produced textiles rarely. This is important to consider when comparing Dürrnberg and Hallstatt textiles. A handful of pieces also can be identified as medieval and early modern in date, as mentioned above, mostly by clear archaeological context and some differences in weave and fibre.

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[16] In two cases a 20th or 19th century date was obtained for some conspicuous pieces. Unfortunately one of the two silk threads found is now much younger in date – in this case perhaps it came from a backfilling of a modern gallery pressed later on the pagan-rock-layer of the Ferro-Schachtricht – a very strict and clean sampling of layers (which is in fact like mining rubbish) cannot always be obtained for sieving.

[17] Barth, Felber and Schauberger 1975.

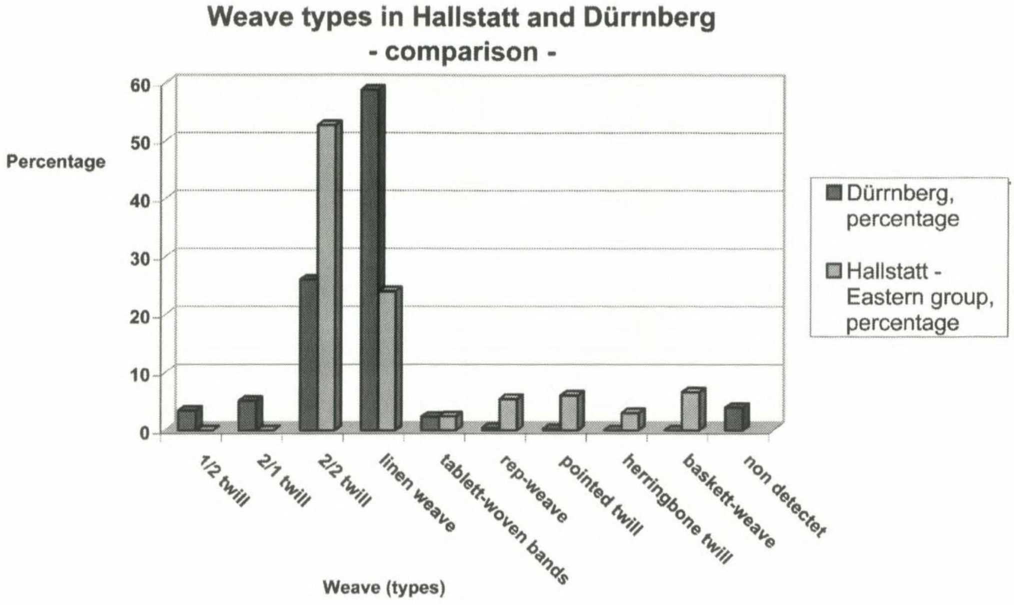

Fig. 8: A comparison of weave-types from Dürrnberg and Hallstatt on the basis of Stöllner 2002/2003 and Kurzynski 1996.

Observations on weaving techniques, fibres and dyestuffs

Recent investigations by K. v. Kurzynski (Marburg) and M. Ryder (Southampton) give an overview of weaving techniques and fibre; textiles typical of the La Tène period made of wool and plant fibres. On the Dürrnberg tabby weaves – fine and coarse – dominate, in fabrics made of hemp/flax or of wool. Twill weaves likewise are numerous but at all mining sites the regular 2/2 twill is predominant. In comparison the 1/2 or the 2/1 twill are known in much smaller proportions and this applies to other weaves too, like tablet-woven bands, rep weaves or other specialised twills. There is only one example of twill with point repeat (Spitzkoeper) up to now. This generally stands in contrast to the fabrics of Hallstatt recorded by H.-J. Hundt and K. v. Kurzynski[18]. While on the Dürrnberg tabby weaves (linen weave) have a portion of 50 % compared with 25 % for 2/2 twills, it is the other way round in Hallstatt (Fig. 8). The occurrence of weaving patterns is more common in Hallstatt. Herringbone twills as well as twills with point repeat are found often in Early Iron Age contexts, accompanied by rep- and basket-weaves. This produces a picture more varied for Hallstatt fabrics. Nethertheless the Dürrnberg weavers created a number of very artistic decorative schemes and spinning patterns. In some cases a so called "flying thread" was identified, which can be the basis of different ornamental patterns. In one case such a fabric was decorated quite elaborately with small S-shapes, triangles and a sand-glass motif[19]. Often the Dürrnberg textiles are decorated with woven stripes, often different in colours, natural as well as dyed ones[20].

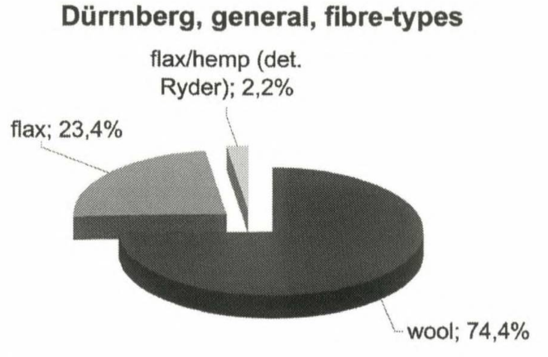

Fig. 9: Percentage of animal and plant fibres at the Dürrnberg salt-mine complex, on basis of Stöllner 2002/2003 and M. Ryder. Note that hemp is certainly underrepresented as Ryder only investigated a small portion (© Th. Stöllner).

In considering the fibres there are also striking differences: besides wool, flax and flax/hemp occurs in considerable quantity on the Dürrnberg – nearly 25 % of fabrics were made of plant fibres while in the Hallstatt Eastern group we have not a single example (Fig. 9). According to the investigations of M. Ryder there were also developments in wool fleece types – Ryder's classification and his discussion make clear that at the Dürrnberg finer and more developed fleece types were in use (Fig. 10). There are fewer of the primitive Hairy-medium and Generalised-medium wools which are favoured in Hallstatt[21]. In addition more of the "modern" Medium and Semi-fine wools were detected in the Dürrnberg material. Ideally one would expect

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[18] Hundt (1959; 1960; 1967; 1987) has published already 109 fabrics, K. v. Kurzynski later worked on further 53 samples; these are the basis for the later on published statistics (Kurzynski 1996: 31-33, 111). Nowadays more than 200 textile complexes are known, for that see reports and essays in this volume.

[19] Kurzynski 1998.

[20] Kurzynski 1996 and 2003.

[21] Ryder 1990.

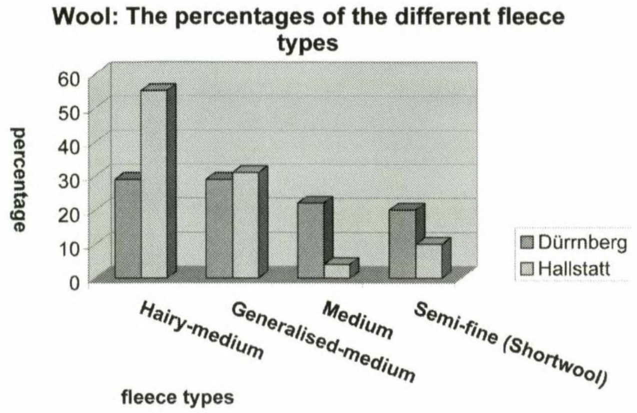

Fig. 10: Percentage of fleece types from Dürrnberg in comparison with those from Hallstatt, investigated by M. Ryder (1990; unpublished).

warp yarns to be thin (tightly spun) and straight and weft yarns to be thicker and wavy. Ryder especially has found evidence that for warp yarns stronger, hairy medium wool was used more often than for weft yarns, where fine, generalised medium wool dominates. The more 'modern' status of the Dürrnberg wool can be explained by the more 'modern' date of Dürrnberg fabrics. In view of the chronology of the textile assemblages sheep-keeping and wool selection must have developed in quite a short space of time (between the 7th and the 6th/5th century BC). M. Ryder also tried to distinguish flax and hemp fibres by their thickness. But Ryder was uncertain at the end about this and other criteria for differentiation. So he doubts the correlation of natural z-twists of hemp and those twists in hemp-yarns since other natural twists have been observed in some other areas. Anyhow it is interesting that hemp was also detected by botanists in the water-logged settlement of Ramsautal at the Dürrnberg – a further hint that points to the local use of hemp[22].

Nearly 40 % of the Dürrnberg textiles show traces of dyeing (Plate 19). Thanks to the salt these dyes are still impressively preserved as bright colours. Besides natural colours such as beige, brown and black we find reddish brown, bright red, blue, bluish-green and olive-green – the latter certainly are more or less intentionally coloured fabrics. But there still remains some uncertainty as we may even reckon on the possibility of detecting dyestuffs also in other fabrics, whose colouring effect has not been preserved. So the percentage presented may not reflect the true proportion of dyed to non dyed fabrics, although in general it points to comparatively high number of dyed fabrics. In the Dürrnberg material there are textiles dyed overall, but at the same time we also find textiles with a single or a couple of coloured yarns woven into the fabric as decoration.

In the course of an EU-Project it became possible to investigate a considerable number of the Dürrnberg fabrics for their dye constituents. The analyses were carried out by Dr J. Wouters and M.-C. Maquoi (KIK/IRPA Brussels) using High Performance Liquid Chromatography (HPLC)[23]. The series analysed comprised 30 fabrics, some including a range of coloured yarns. A total of 58 analyses was eventually carried out of which 41 samples revealed dye constituents (Fig. 11). It was interesting that some of the bright coloured fabrics (yellowish, blue and olive colours) did not produce any dye consituent while some of the brown yarns in fact indicate that they were coloured originally. It is very likely that degradation products influence the actual hues to a great extent and that the intensity of colours is not representative of the amounts of actual dye constituents, especially in the brown hues. The variation among the dye constituents found was standardised and not very variable: blue and yellow colours can be traced back to *Isatis tinctoria*. Presumably woad was used, the classic dye for blue before the introduction of Indigo to the European markets. Considerable amounts of the colouring agent Indirubin indicate that blue textiles were dyed by vatting under the influence of sunlight. Other dye-sources were traced for reddish brown colours, where investigations probably proved an elaborate use of dyestuffs like *Sambucus nigra*, *Reseda luteola*, weld, and tannins. A combination of tannins and weld suggests that they also mixed certain dyeing agents. This also seems true for green colours, possibly a mixture of weld with woad. In other cases we have evidence for imported dyestuffs from the Mediterranean – in some bright red colours traces of Kermesic acid and of alizarin where detected. These red dyeing agents were probably produced from *Kermes vermilio coccoidea*, a louse species that normally lives in holm oak forests in the Mediterranean[24] (Plate 19). On the other hand the dyestuff *Rubia*

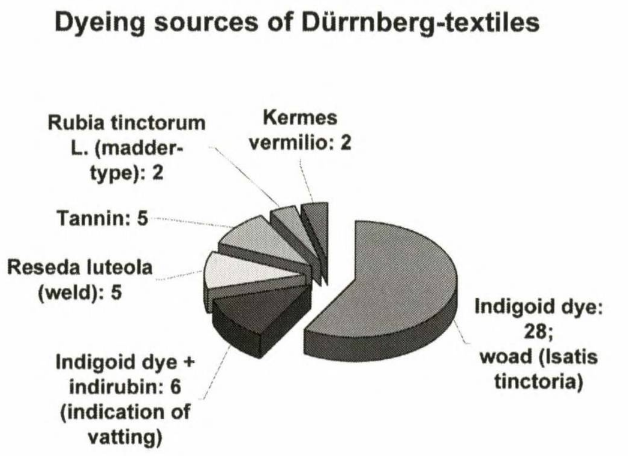

Fig. 11: Dye sources of the Dürrnberg textiles: evidence for each dye sources (after J. Wouters and M.-C. Maquoi, Brussels).

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[22] Swidrak 1999. – Swidrak and Schmidl 2002: 148.

[23] J. Wouters and M-C. Maqoui, Dye analysis of Iron Age fabrics. Dürnberg Project. Unpublished Report 1999. All analysis carried out for the Dürrnberg fabrics will be published together with K. v. Kurzynski's PhD-thesis. In order not to anticipate a final publication I just give some general information on the results.

[24] Walten-Rogers 1999: 240-246.

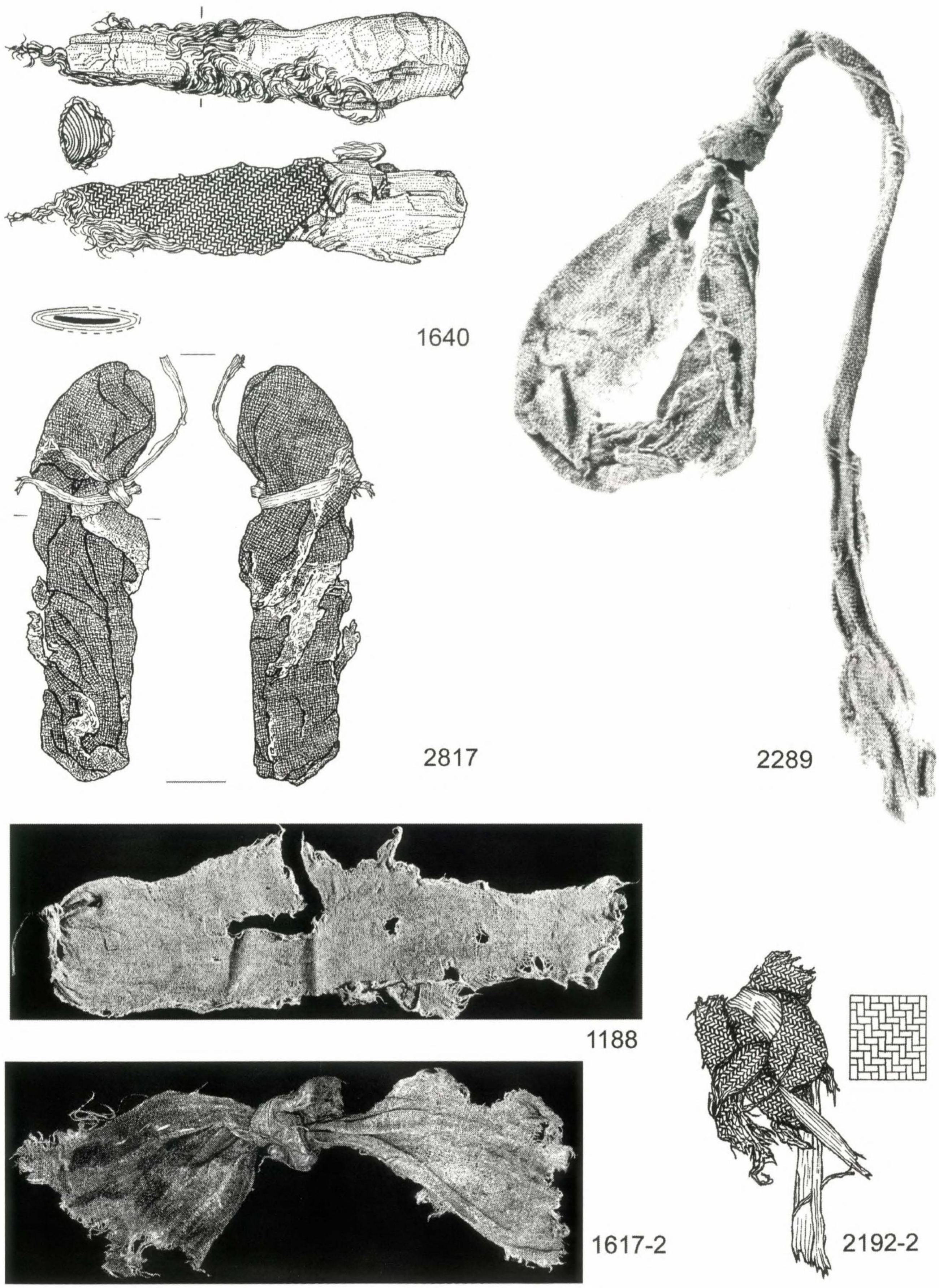
1640
2817
2289
1188
1617-2
2192-2

Fig. 12: Textiles from the Dürrnberg salt-mine in "secondary" use (drawings: M. Krause, Marburg. – Fotos: V. Ilic, Belgrad).

tinctorum is evidenced (at that time not in use north of the Alps)[25] The fact that they are combined in one case may indicate the use of mixed red dyes and perhaps their transport to the northern Alpine regions The same result was obtained for the princely tomb of Hochdorf, although the red dyestuff was used there for quite a large piece of fabric[26]. At the Dürrnberg only decorative threads were coloured with it.

Interpretation of textiles as an important aid to mining

The plentyiful of richly decorated Iron Age textiles from Hallstatt and from the Dürrnberg have often been discussed with respect to to the mining process[27]. The questions raised by H.-J. Hundt are still worth thinking about especially in the light of textiles found in the older Late Bronze Age contexts of Hallstatt. Just rough and partly worn working equipment made of cloth was found there, which even more underlines the vagaries of post-depositional contexts, but also the special situation in the Eastern Group of Hallstatt and the Late Hallstatt to Early La Tène mines of the Dürrnberg. It has often been pointed out that the fragments came underground already as rags for some special purpose (see also above)[28].

Apart from such general considerations, there are still the fragments which provide information about their previous use before being deposited in the waste dump of a salt-mine. Larger pieces were often torn deliberately into strips. Perhaps this was done shortly before use; for this kind of "ad hoc" conversion was done most probably underground. There are indications that such rags then helped to fix iron picks in their hafting (Fig. 12/1640) or to repair a broken wooden handle by wrapping and fixing it[29]. Loops show sophisticated preparation for quick connection, possibly for hauling devices – for example to fix something when hoisting up loads (Fig. 12/2289).

In contrast to leather straps that may also have been used for heavier connections such as to secure removable wooden working platforms, fabrics seem to have served as joining materials in a personal context. Often we found very small links made of of bast fibres and fabrics, sometimes just a fibre with a yarn (Fig. 12/2192-2). In other cases heavy knots indicate heavier weights that had to be handled – perhaps these belonged to hauling devices (Fig. 12/1617-2).

Archaeological work also produced more or less complete artefacts such as fingerstalls and bundles wrapped and fixed by bast strips or yarns (Fig. 12/2817). The fingerstalls obviously reflect the importance of textiles as a hygienic device. Besides fingerstalls bandages can also be identified – for example find number 1188 that was fixed presumably by a bast strip adjusted to fit when wrapped up (Fig. 12/1188). Perhaps such bundles were prepared centrally for the miners and given to them when they entered the mines. In this regard these bundles remind us of the famous *petasites officinalis* (butterbur) bundles that were found in large numbers in the Eastern group of the Hallstatt salt-mines[30].

Textile production at the Dürrnberg – household work or craft production?

Finally we may ask if the considerable differences between the Hallstatt and Dürrnberg textiles reflect also important changes in the way textiles were producedin general. To sum up: most of the Dürrnberg fabrics date to the Late Hallstatt and Early La Tène periods and represent a later chronological stage in comparison with the Hallstatt Eastern group textiles. They seem to be more standardised and less varied. Weaving was done generally with finer wools: one quarter of the textiles were of plant fibres. There are reasons to think that the plant fibres were worked locally. On this assumption the fine linen made of flax is particularly remarkable.

In order to understand the production of fabrics we have to look at production modes in general. At the Dürrnberg a remarkable concentration of different crafts can be observed. They were especially flourishing while the mines also produced salt on a large scale (this has been discussed elsewhere)[31].

This interdependency clearly underlines the fact that salt and its immediate products like pickled meat and refined leather and skins were a primary product of the Dürrnberg while others range on a secondary level but were likewise important for the regional markets. For the Dürrnberg it seems more clear than for Hallstatt that a regional hinterland (especially the Salzach valley, the Salzburg basin and the northern Alpine foreland) were close trade-partners and supplied the Dürrnberg salt-mining centre[32].

The character of local crafts can be studied at the best in the Ramsautal where several excavations have provided an insight into workshop and domestic structures[33]. Besides butchery there is evidence for smelting and smithing iron and non-ferrous metals, glass-working, pottery-production and for wood-working like lathe-turning as well as for pro-

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[25] Körber-Grohne 1987: 419-423.

[26] Banck-Burgess 1999: 85-89.

[27] Hundt 1987: 285 f.

[28] Hundt 1987: 285 f. – Kurzynski 2003: 154.

[29] E.g. Klose 1926.

[30] Kromer 1985.

[31] E.g. Stöllner 2002.

[32] Stöllner 2002. – Stöllner et al. 2003.

[33] Zeller 1984. – Stöllner 1996. – Löcker and Lobisser 2002. New excavation on the north-eastern fringes of the Ramsautal were carried out by the Österreichisches Forschungszentrum Dürrnberg (ÖFD) in 2003 and 2004 under direction of St. Moser. At the Putzenfeld a settlement area gave evidence of smelting of nonferrous metals were finds of half-finished products and crucibles. For information I am grateful to Mag. St. Moser, ÖFD Hallein.

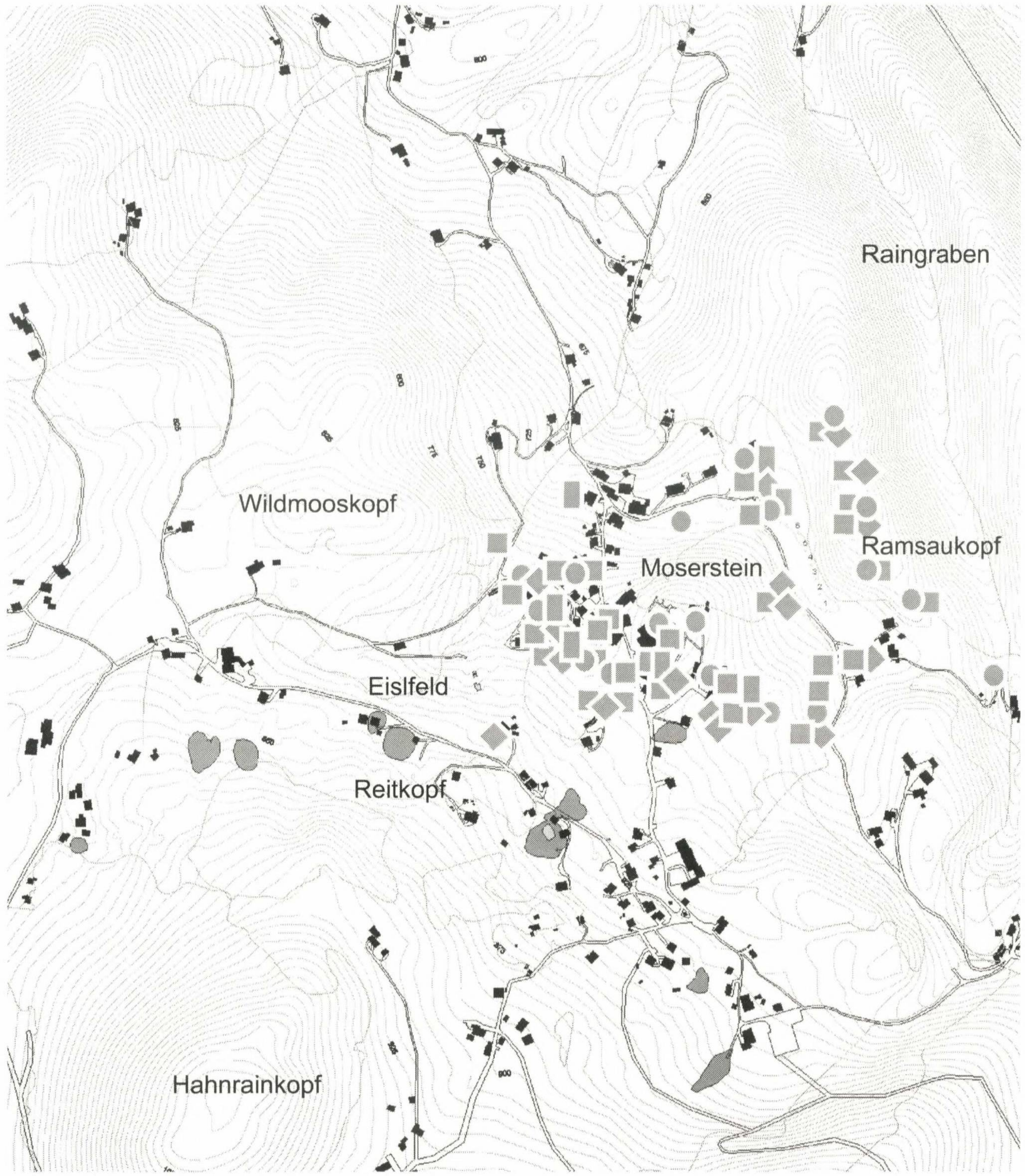

Fig. 13: Weaving implements found in settlements at the Dürrnberg, after Brand 1995, Fig. 84; quadrangles: spindle whorls made of ceramic sherds, points: spindle whorls, rectangular symbols: loom weights; lozenge: "play-stones". Irregular shaded areas represent mining tailings in the Dürrnberg Mining area, south west of the central settlement area (© Th. Stöllner).

ducing tools. These crafts are not only concentrated in the Ramsautal: the distribution of slags, crucibles or tools and other production waste possibly associate the whole settlement with these crafts-processes[34]. To what extend processes were concentrated on sites like the Ramsautal is still a matter of further research as we have far too little knowledge about details of craft production in individual areas.

There is no doubt that weaving and spinning were common at the Dürrnberg. The distribution of implements like whorls and loom weights clearly shows that for all settlement areas (Fig. 13). What may be deduced from such a picture is just that textile work was common in many households – which at a first glance contradicts the theory of craft-production. While loom weights are not very often represented in comparison to spindle-whorls one could suppose that spinning was more common than the actual production of fabrics. Spinning may have been an everyday task in most of the households but the weaving could be handed over to some specialised craftspersons. Strikingly heavier loom weights are rare[35] and loom weights for vertical looms may not have played a dominating role. The production of tabby fabrics of flax, sometimes very fine linen, may have required to (re-)introduction of horizontal looms (two-beam looms).

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[34] Brand 1995.

There are still many questions unsolved concerning fabric production at the Dürrnberg, especially regarding the technical aspects. On present knowledge it appears likely that textiles were produced on a specialised basis. In this respect it is worth debating whether textile production also became an important secondary-level craft at the Dürrnberg, its products being used not only at the Dürrnberg but also delivered to the local markets.

Mehr als alte Fetzen – Textilien aus dem eisenzeitlichen Salzbergwerk von Hallein-Dürrnberg

Die Textilfunde zählen zu den Ausgrabungsschätzen der langjährigen Untertageforschungen (1990-2004) im Salzbergwerk des Dürrnberges. Mittlerweile sind etwa 600 Textilkomplexe geborgen worden, die einen umfangreichen Eindruck über den Grundrohstoff Textil in der frühen Eisenzeit, besonders zwischen dem späten 6. und dem 3./2. Jahrhundert v. Chr. geben.

Die meisten Textilfunde sind in "sekundärer" oder "letzter" Verwendung im Heidengebirge des Salzbergwerkes – meist stark zerschlissen und abgenutzt – aufgefunden worden. Die Analyse der Ablagerungsbedingungen zeigt Ansammlungen an bestimmten Stellen an, so etwa an Reparaturplätzen und zugehörigen Abfallbereichen. In einigen Fällen ließ sich auch die ursprüngliche Weiterverwendung im Bergwerk noch klären.

Das Gros der Textilfunde gehört in die späte Hallstatt- bis in die mittlere Latènezeit, entsprechend der Abraumschichten des prähistorischen Bergwerkes. Da aber einige der eisenzeitlichen Abraumschichten des Salzabbaues in jüngerer Zeit (zwischen dem 14. bis 17. Jahrhundert n. Chr.) wieder aufgefahren wurden, liegen in mehreren Fällen Störungen vor. Diese Problematik wird in ihren Konsequenzen diskutiert.

Die vielen, auch reich verzierten Textilfunde waren schon in der älteren Forschung häufiger diskutiert und in ihrem Verhältnis zum eisenzeitlichen Bergbau hinterfragt worden. Wir gehen davon aus, dass die meisten Funde als Lumpen in Zweit- oder Drittverwendung in die Grube gekommen sind und dort als Hygieneartikel, als Handhaben, als Verbandsmaterial oder für geknotete Verbindungen gedient haben.

Die bisherigen Untersuchungen durch K. v. Kurzynski (Marburg), J. Wouters (Brüssel) und M. Ryder (Southampton) zeigen typisch latènezeitliche Gewebearten aus Wolle und pflanzlichen Fasern; dabei lassen sich markante Unterschiede zum älteren Hallstatt herausstellen. Häufig sind auch bunt gefärbte Stoffe sowie die Verwendung von exotischen, besonders gefärbten Zierfäden.

Im Textilbestand des Dürrnberges fällt die weitaus stärkere Vereinheitlichung von Webmustern und Faserstoffen etwa im Vergleich zum älteren Hallstatt auf. Feine Leinengewebe aus Flachs oder Hanf kommen in großer Zahl vor und lassen an die stärkere Verwendung horizontaler Webstühle denken. Nach dem Zeugnis der Siedlungsfunde ist das Textilhandwerk in der gesamten Siedlung verbreitet und mag so wie andere Handwerkszweige eine über den lokalen Bedarf hinausgehende Produktion andeuten.

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[35] Brand 1995: 55.

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Curriculum vitae

Born in Austria 1967, educated at the Universities of Salzburg, Vienna, Regensburg and Marburg. Posts at the Univerity of Marburg, since 2000 head of department for Mining Archaeology in Bochum. Teaching at the University of Marburg, Bochum and the Flinders University of South Australia about European Iron Age and Mining Archaeology in Europe and Near Eastern Archaeology. Member of the German Archaeological Institute and Kommission für Allgemeine und Vergleichende Archaeologie.
Current projects: Iron Age Salt-Mining at the Dürrnberg; Copper-Mining at the Arthurstollen, Bischofshofen; Celtic Iron Production in the Siegerland; Prehistoric Copper-Mining in Veshnaveh, Iran; Copper and Tin in Central Asia (Kazakhstan). Publications: Die Hallstatt- und der Beginn der Latènekultur im Inn-Salzach-Raum, vol. I/II (1996, 2002); Prähistorischer Salzbergbau am Dürrnberg bei Hallein I, II (1999, 2003); Man and Mining. Studies in honour of.. (2003); Europa celtica (1996).

The State of Research of La Tène Textiles from Slovakia and Moravia

Tereza Belanová

Abstract

The most complex collection of archaeological textiles from the territory of Slovakia and Moravia, dated to the La Tène period, is considered. Questions about working with this sparse material are discussed and new trends in renewed textile research using interdisciplinary approaches are reviewed. The preliminary results are given of macro- and microscopic analyses.

In diesem Artikel wird die überaus komplexe Sammlung archäologischer Textilfunde aus der Slowakei und Mähren behandelt, in diesem kleinen Rahmen können jedoch lediglich die latènezeitlichen Funde berücksichtigt werden. Es werden sowohl Fragen bezüglich dieses Materials diskutiert, als auch neue Ansätze in der Erforschung der Textilien in Zusammenhang mit interdisziplinären Forschungen. Es wurden neue makro- und mikroskopische Analysen durchgeführt, deren erste Resultate hier vorgestellt werden.

Introduction

An interesting collection of archaeological textiles has been recorded from the territory of Slovakia and Moravia. Though the finds are rather scarce, they deserve their place in European textile research. Attention should be paid to every little potential textile fragment sealed or stuck to metal artefacts, as well as to the textile impressions on various materials or fragments of charred threads and cords.
Unfavourable soil conditions for the preservation of such fragile organic remains as textiles in this geographical area are the main reason why the textile collection is not larger. As a result, there is a tendency to overlook textile finds, which consequently leads to lack of published material. Moreover, the work with such scarce and inaccessible material is considered to make little contribution to the knowledge of society at that time. It is sad, that although various published works from Northern Europe have showed that every little textile fragment offers unique and important information, this archaeological resource is constantly neglected.

In the past, only a few authorities dealt with research on archaeological textiles from the territory (above all those dated to the Hallstatt and La Tène periods). First of all the Scandinavian specialist Lise Bender Jørgensen (1992) included the finds from territory of former Czechoslovakia in her work on North European textiles[1]. Marie Kostelníková (1973, 1988) dealt with the analyses of textile finds from Moravia and Bohemia. She mostly focused on Great Moravian textiles of the 9th and 10th century but she also worked with textile remains from several other periods (Kostelníková, 1978, 1985, 1987, 1990a,b, 2002)[2]. Helena Bœzinová (1996, 1997, 2004) built up a general picture of medieval textile production for the territories of Bohemia, Moravia and Slovakia. A concise picture of Slovak textile finds was drawn by Karol Pieta (1985, 1992) who focused on a number of La Tène textile remains[3]. Slovak and Czech finds were also mentioned by Katharina von Kurzynski (1996) in the context of Hallstatt and La Tène textile remains and by Johanna Banck-Burgess (1999) in her catalogue of textile finds from the princely tomb at Hochdorf.
A renewed research project on archaeological textiles in Slovakia which started in 2003 is aimed at collecting all accessible sources on the textile production from the territory and by using new methods to revise the most complex assemblage of La Tène textile fragments from Moravia and Slovakia.

The goals of the research

The main intention is to undertake a series of advanced analyses incorporating special microscopic techniques like study of fibres by polarised light and SEM, which would

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[1] Some of the published Moravian La Tène material is at our disposal, together with original analyses from L. Bender Jørgensen. It has been reviewed and completed recently. For other information see also the paper by L. Bender Jørgensen in this volume.

[2] M. Kostelníková analysed a large collection of Moravian La Tène textile finds, but unfortunately did not manage to publish. Most of her analyses are at our disposal.

[3] Present research is revisiting the older material from Slovak grave finds of La Tène period. Most of the older analyses we have at our disposal.

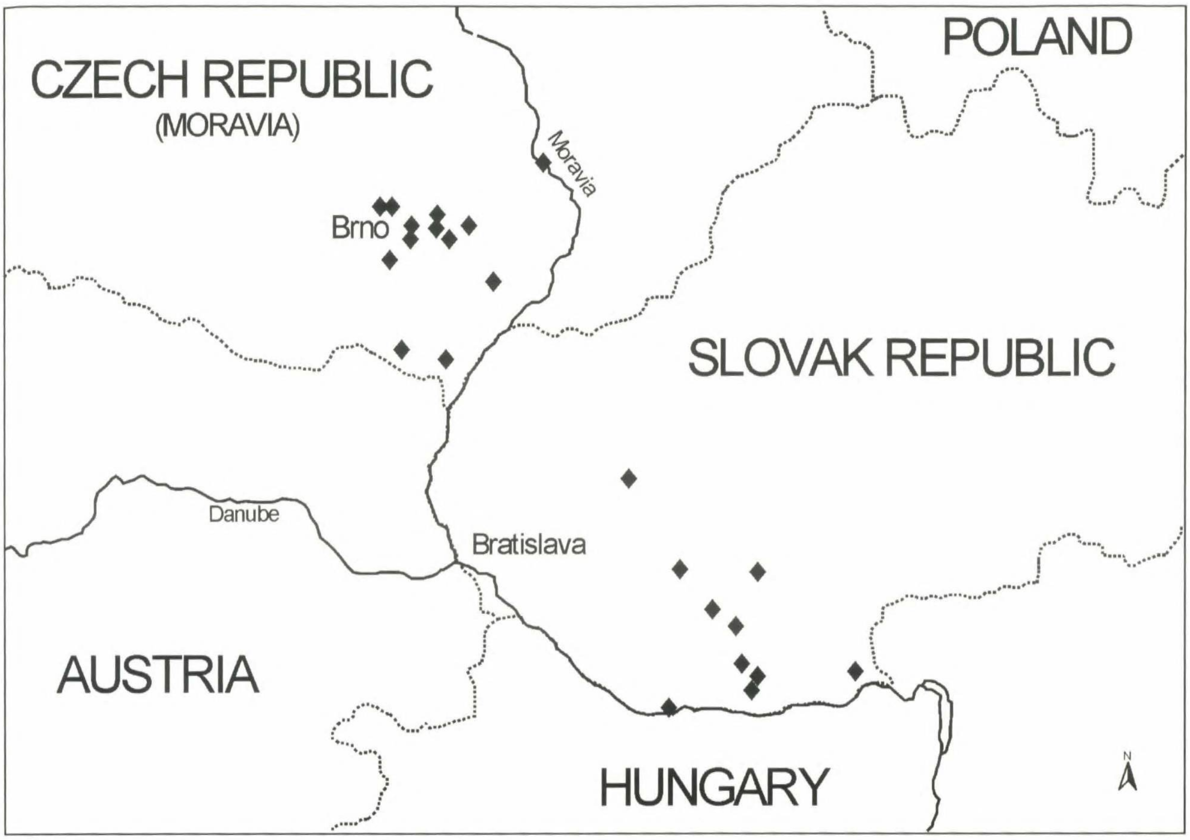

Fig. 1: The territory of south-west Slovakia and southern Moravia. Slovakia: Bučany, Hurbanovo-Abadomb, Hurbanovo-Bacherov majer, Chotín, Kamenín, Malá nad Hronom, Malé Kosihy, Maňa, Nové Zámky, Palárikovo, Svätý Peter, Trnovec nad Váhom, Moravia: Blučina, Brno-Maloměřice, Brno-Židenice, Bučovice, Holubice, Křenovice, Miroslav, Mušov, Nížkovice, Postoupky, Sedlec, Slavkov, Stará Břeclav, Svatobořice-Mistřín, Telnice.

enlarge knowledge, for example as to type and quality of fibres used and spin pattern. Discussions with an ethnologist, who provides knowledge of traditional textile techniques and their position in contemporary European and non-European cultures, widens the possible ways of interpreting and reconstructing historical and prehistoric techniques and the role of textile production in past societies. Cooperation with skilled conservators provides proper conservation and/or restoration of textile fragments and their preservation for future research. The individual finds are evaluated in wider European context, but their local importance is being stressed. The collected data are being statistically processed and a multilevel database of finds and related information is being prepared. Ultimately, application of all knowledge gained is being tested in experiments and eventually will be presented to specialists as well as to the public.

Chorology and chronology of the finds

The available textile fragments (many of these were analysed several decades ago[4]) originate from the northern part of the Middle Danube area, more precisely from the territory of south-west Slovakia and adjacent area of southern Moravia (Fig. 1). They all date to the La Tène period and belong to the same "cultural group".

Only primary sources – textile fragments recovered from the graves – were taken into account. The majority of textile fragments belong to the phases LTB$_1$, LT B$_2$ and LT C$_1$, which are in Central Europe commonly described as the horizon of "*flat Celtic inhumation graves*"[5]. Two cremation graves from Bučany dated to the late Hallstatt and early La Tène period are the exception. The textile finds were recovered almost exclusively from rich male warrior and rich female graves. Most textiles come from inhumation graves, fewer from the cremations and several finds are of unknown origin. The groups of finds, Slovak and Moravian, are comparable and analogous.

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[4] Analysed by L. Bender Jørgensen, M. Kostelníková, K. Pieta, J. Opralová and H.-J. Hundt.

[5] Bujna 2004: 321.

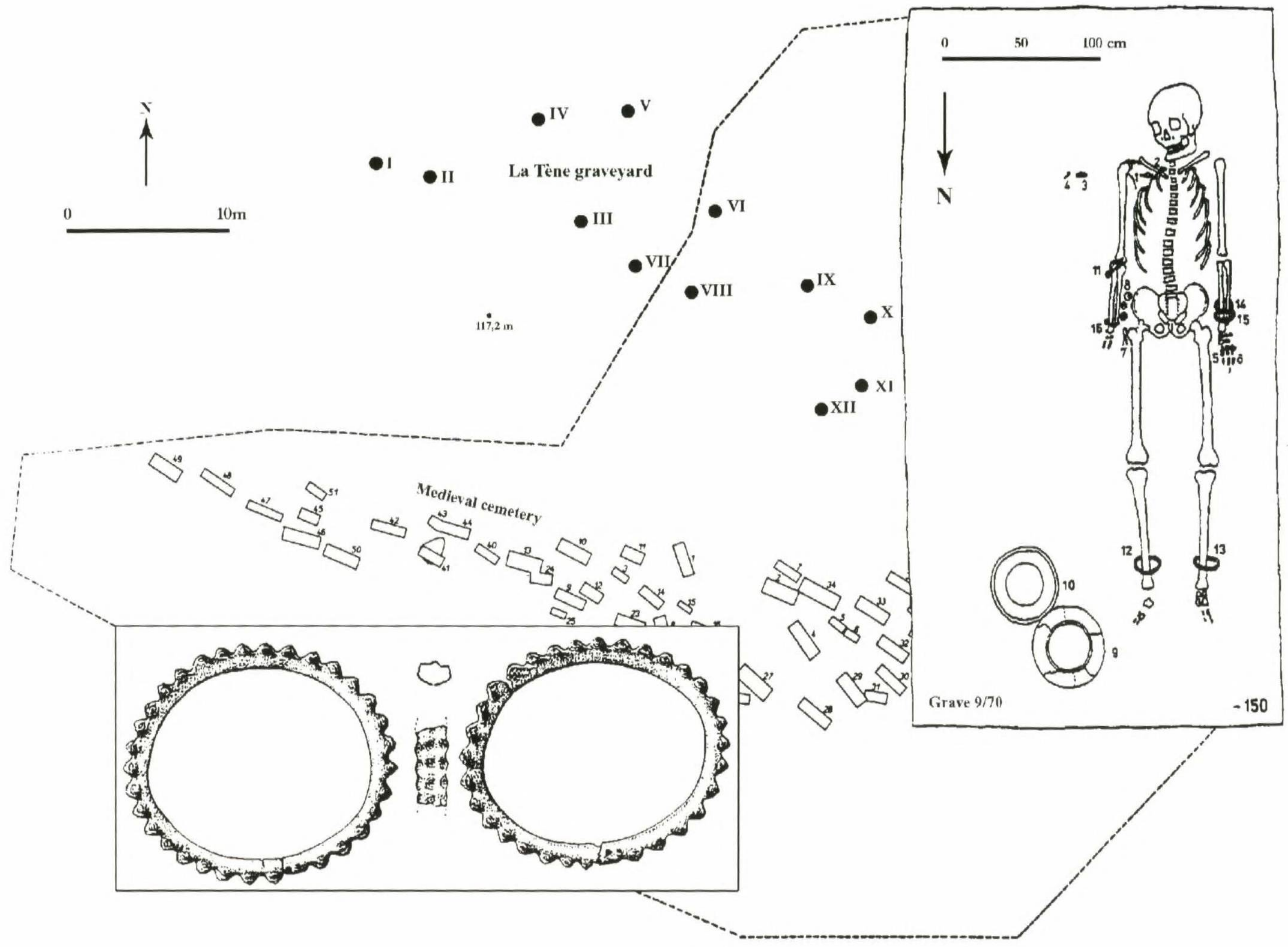

Fig. 2: The map of small La Tène graveyard in Nové Zámky. Female grave 9 with pair of anklets, detail in the left corner (based on E. Rejholec 1971, K. Pieta 1992).

Mode of preservation

As already mentioned, apart of a few exceptions, the preserved textiles are often very fragmented and most of them are mineralised. In some cases mineralization and corrosion works destructively and leads to complete destruction of fibre anatomic structure. By analysing such objects, the structure of the fabric could be read, but organic (vegetable or animal) material cannot be identified. On the other hand the partial (mild) mineralization enables identifiable organic material to be preserved, which would otherwise decompose.

Textile fragments from La Tène graves in Moravia and Slovakia found in rich warrior graves adhere to iron sword sheaths, lance heads, knives, razors, iron fibulas and belt rings. In female graves, pieces of textiles are found on fibulas, bracelets or inside the tubular sheet anklets. Tubular anklets made from bronze sheet appear often in west Slovakian female graves, but are found in a few pieces on Moravian sites, too. These anklets with transversely ribbed hoop and moulded decoration of triple protuberances[6] are specific decoration of "East-Celtic" women[7]. Usually, two tubular anklets are situated on each ankle of the deceased. They represent the most fruitful source of textile information. If it has not fallen apart, we can find a piece of twisted fabric inside. In the majority of cases the anklet is filled with fine clay and sometimes the piece of textile lies in the ends of tube[8].

The anklets filled with twisted pieces of fabric are known from several Slovakian sites. Embroidered pieces of textiles from Nové Zámky (grave 9)[9] (Fig. 3), textiles from graves 55 and 58 in Svätý Peter and similar finds from Trnovec nad Váhom (grave 234) and Hurbanovo-Bracherov majer (grave 11)[10] have to be mentioned.

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[6] Bujna et al. 1996: 71.

[7] Bujna 2004: 326.

[8] Pieta 1992: 56. Anklets filled with clay are found e.g. in Hurbanovo-Bacherov majer, grave 6; Kamenín, grave 16; Trnovec nad Váhom-Horný Jatov, grave 233; Dubník, grave 7, 12. Anklets filled with clay and closed by so-called 'textile plug' in their ends are found in Maňa, grave 113, 116.

[9] For detailed analysis see also Pieta 1992.

[10] Svätý Peter: Dušek 1960, Trnovec nad Váhom and Hurbanovo-Bacherov majer: Benadik et al. 1957.

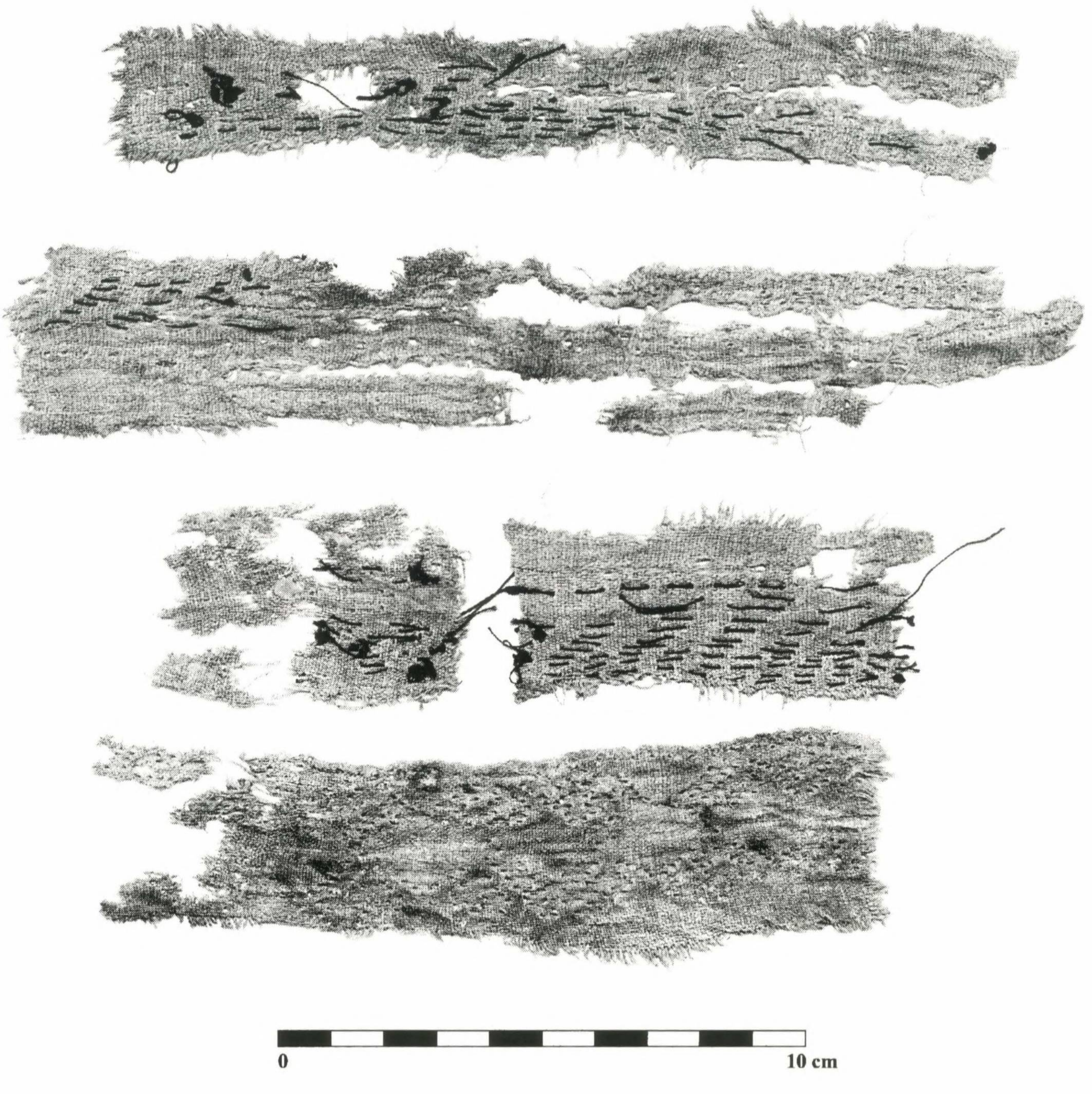

Fig. 3: Nové Zámky, grave 9: Embroidered linen fabrics taken out from bronze sheet anklets (© Tereza Belanová).

The Moravian finds are similar. Bronze tubular anklets were recovered at the largest La Tène graveyard in Brno-Maloměřice (graves 48 and 67)[11]. They were filled with twisted pieces of textiles, which showed a resemblance to Slovakian finds. We can learn about these finds from the hundred year old records of Alois Procházka, a Czech "Gaul" expert at the time. Let us see what he writes about similar finds from Nížkovice, grave 4: "*These rings are hollow and made of sheet metal. Transverse rows with three bulges were beaten into a very thin bronze sheet; thereafter this sheet was rolled up in a tube, so that the lengthwise edges were not joined, but there was a narrow gap. The tube was rolled in the form of a ring. The fabric from these two rings, which was laced through the socket and preserved by patina is very interesting. These anklets comprised of entirely closed rings. This was achieved by thinning of one end in a jag and sliding it into the socket of the other*"[12].

Similar finds come from La Tène graves in Miroslav and Mušov.

It is worth mentioning, that there are today tubular anklets, which are still filled with twisted fabric and have not been opened. Specialists debate the function of clay or textile

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[11] Poulík 1942: 69-70. – Čižmářová 2004.

[12] Procházka 1909: 206-207, translated by author.

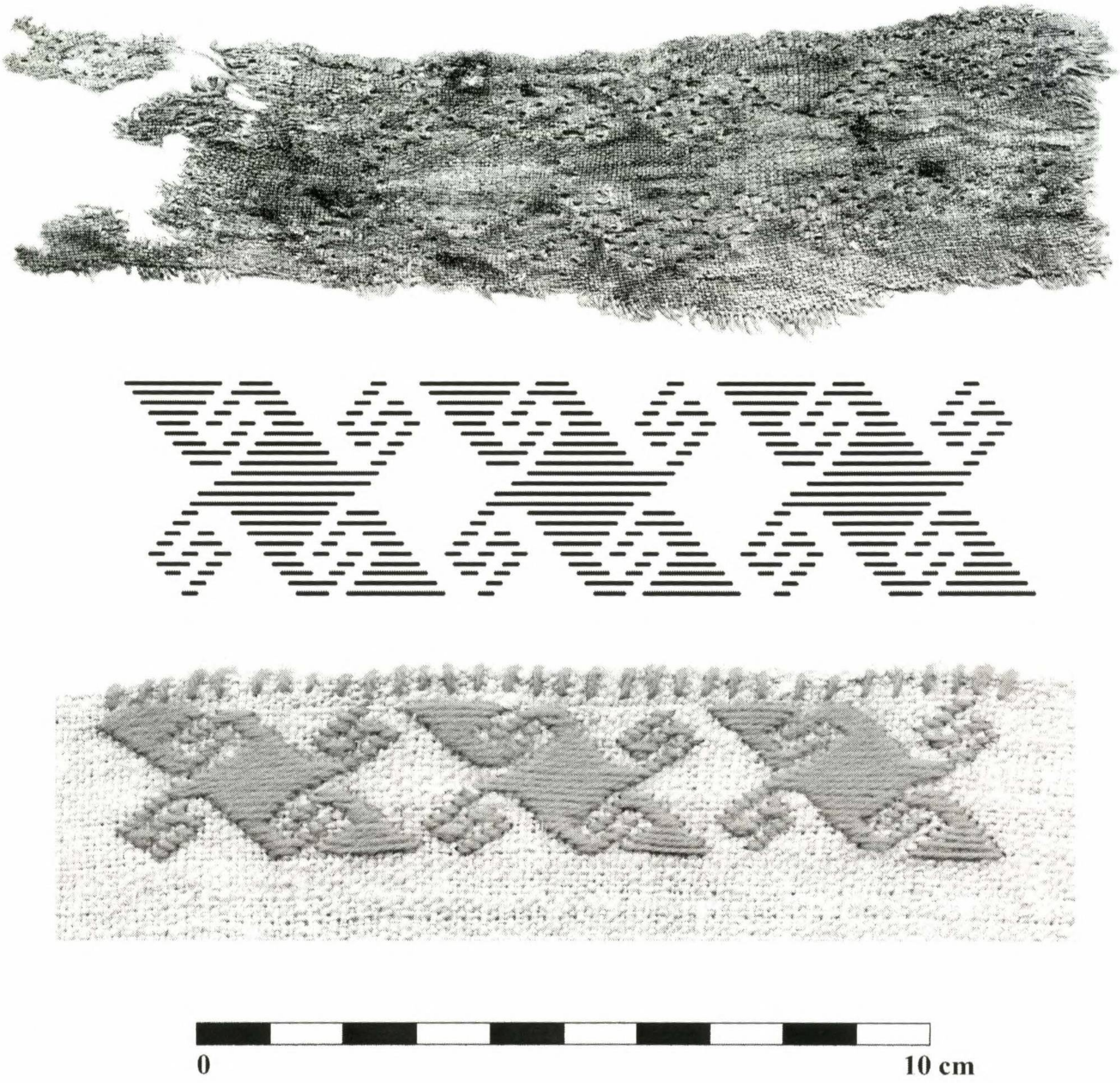

Fig. 4: Embroidered fragment of textile from grave 9, Nové Zámky (Reconstruction of embroidery by T. Belanová and J. Zajonc, 2004).

pieces. According to author they bear witness to the technology of production. Some archaeologists deal with usual problem: 'to destroy the anklet because of a tiny scrap of textile?' From the point of archaeological textile research, there is only one solution: 'and what if there is hidden an embroidered piece or other unique information?' We are working on a method to find a way, of taking out the fabric without entirely destroying of the anklet.

As pilot analyses 130 samples from 92 graves (27 cemeteries) have been studied. Due to the bad state of preservation of the finds, relatively large numbers of the fragments were of indeterminate character. Most of the mineralised fragments were too small to define the cloth type and assiciation with metal and other contaminants on the fibres prevented their species determination. In some cases however determinations could be made.

Finds from the territory of Slovakia

79 samples in Slovakia (from 58 graves) were studied. Most frequent were metal objects with textiles replaced by corrosion products. It was calculated that fabrics in tabby predominate (61 %), plain twill is very rare (5 %) and high number (34 %) was left as unspecified.

Even more biased information has been obtained for utilisation of fibres. Flax was identified in 27 % and hemp in one while the rest (72 %) of the finds stayed undetermined. Plain twill occurred on the edge of sword sheath in most of the cases. From grave 28 at Chotín came two cloth-types adhering to each other – a loose one in twill and a dense fabric in tabby on the other side[13]. A unique textile fragment of twill weave and hemp fibre showing a difference from the usual spin direction comes from grave 15 at

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[13] The analysis by J. Opralová, archives of Archaeological Institute Nitra, nr. 10.414/83.

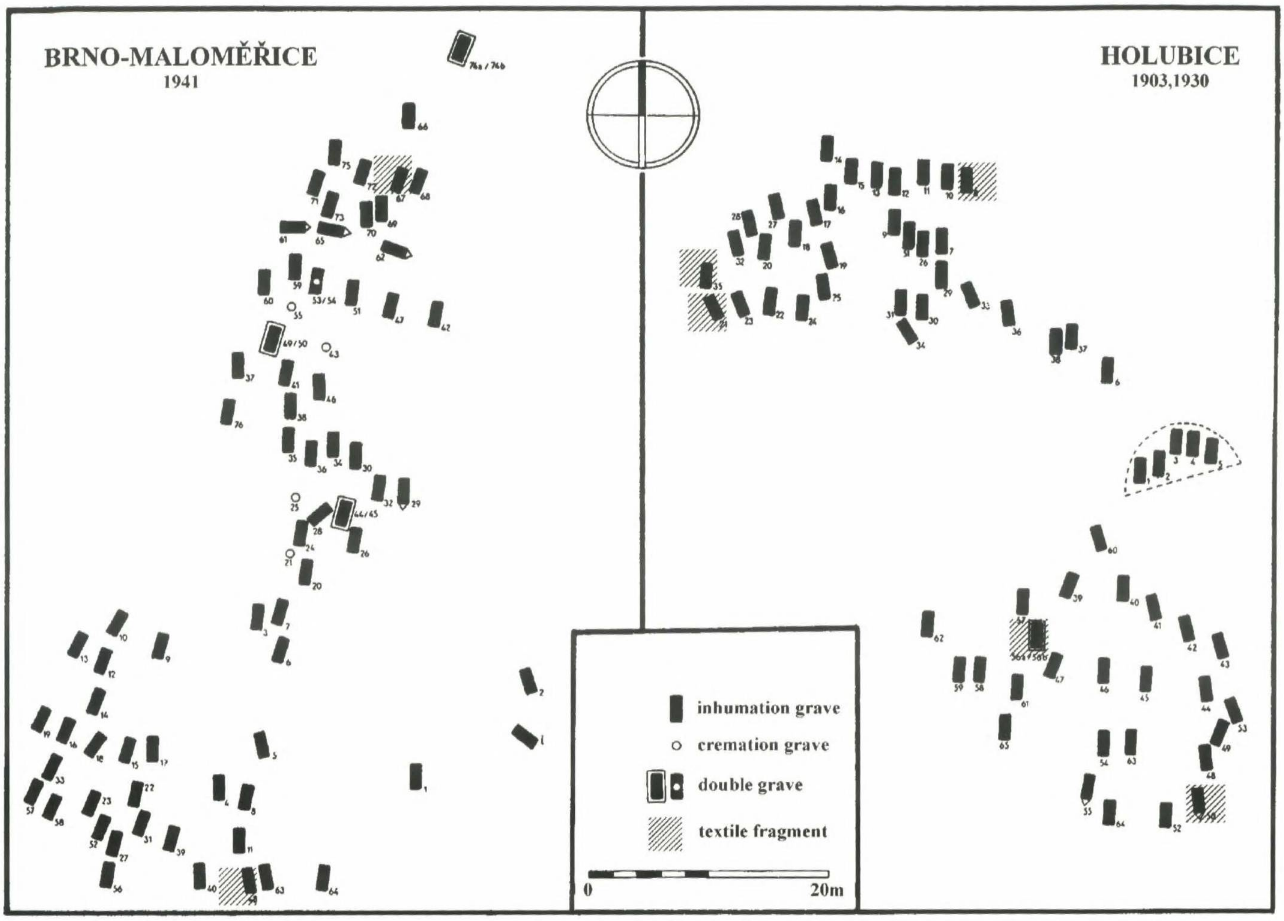

Fig. 5: The map of two largest La Tène graveyards in Moravia – Brno-Maloměřice and Holubice. Graves with textile finds are marked (based on V. Podborský et al. 1993).

Palárikovo[14]. The finds from Slovakia almost have exclusively z/z spin direction in single yarn. The fabric from Palárikovo is an exception and has threads spun in s/s direction. Isolated cords made of plied yarn (Sz) were found at Maňa[15].

Due to the very small size of the preserved fragments a thread count on 1 square centimetre was measured. It was found that the thread count varies from 5-10 threads to 14-28 in both systems – from loosely woven gauze-like to very dense ones. The impossibility of distinguishing warp from weft led the author to attribute the higher number of fibres to the warp and lower to the weft (cf. L. Bender Jørgensen, 1986).

In general, all the fabrics taken out of the bronze anklets were finer in comparison to other finds. Thanks to their better preservation, we can also observe other significant features: stitch-holes (Nové Zámky – grave 9, Svätý Peter – grave 58), weaving faults (Svätý Peter – grave 58) or selvedges, hems and seams (Nové Zámky – grave 9, Svätý Peter – grave 58). Without question, the prettiest and best preserved pieces of textile come from the La Tène female grave 9, in the small graveyard in Nové Zámky (Fig. 2, 3). In a pair of bronze tubular anklets five tattered fabrics were found. They all belong to plain linen tabby with a z/z spin direction of threads and a selvedge with traverse face stitch occurs. Moreover, these pieces were embroidered with woollen thread, in one case red dye was proved[16]. According to the older documentation, the sample of red woollen thread was taken for microscopic analyses (and is lost). As no traces of woollen threads has been preserved on the fabrics, new analyses could not be undertaken. Today, only stitch-holes marking the former embroidery can be seen. Besides, the fabrics were re-embroidered with modern cotton thread to show the pattern in an exhibition. Thread count of this fine fabric was 12-14/20-24. The thickness of the threads varied from 0.5 to 0.8 mm in warp and 0.3-0.6 mm in weft[17]. K. Pieta assumes that all these pieces were originally part of one bigger textile fragment.

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[14] Pieta 1992: 52. The analysis by J. Opralová, archives of Archaeological Institute Nitra, nr. 11.919/87.

[15] The analysis by J. Opralová, archives of Archaeological Institute Nitra, nr. 10.779/84.

[16] Pieta 1985: 56-57. – Pieta 1992: 56-60 and J. Opralová, archives of Archaeological Institute Nitra, nr. 10.410/83, 11.022/85.

[17] I would like to add a note to these former analyses: though it is not a written rule, the warp-threads, stretched on the loom were usually thinner and therefore the density in thread count was higher then in weft direction. The attributes of 12/20 meant 12 threads in warp and 20 in weft, should be probably understood conversely (20/12) and the same with thickness of the thread 0.5/0.3- 0.3/0.5 mm. This applies to most older Slovak material.

We would also like to present here the most interesting piece of all the fabrics from Nové Zámky: "*Two embroidered stripes, which are situated parallel to the selvedge, run in the weft direction. The embroidered motifs are executed in a technique of a face stitch and they consist of changing obliquely placed S-motifs and a trumpet-like pattern reminiscent of an inter-wedged horn of plenty*"[18]. This significant embroidered fragment was experimentally reconstructed on a piece of cloth and the pattern was redrawn, too (Fig. 4, Plate 20).

As for the other Slovakian finds, mineralised pieces of textile occurred mostly on one side of various artefacts, e.g. on fragmentary iron belts from graves 42, 93B, 104 and 138 at Maňa. From the same graveyard two different cloth types adhering to one iron object (grave 93B and 115)[19] were also recovered. Similar finds can be seen on a belt-ring from grave 29 from Chotín, where two types of cloth were attached – a coarse, gauze-like cloth laid over a dense one. In the same grave was found an iron fibula with piece of mineralised textile[20].

In Malé Kosihy (grave 331) next to the skull lay an iron fibula completely wrapped in fabric[21]. A piece of very fine linen tabby was attached to a knobbed anklet from grave 1/80 at Hurbanovo, where the thickness of thread varied from 0.2 to 0.5 mm and thread count of 22/26 per cm.

Finds from the territory of Moravia

The Moravian collection comprises 51 samples analysed from 34 graves[22] (Fig. 5). The mode of preservation was very similar to that of the Slovak material and textile fragments were mostly attached to iron objects. Along with these, there is a collection of textiles taken from inside tubular anklets.

Tabby weave predominates in 68 % of finds in this collection, too: 8 % comprised of plain twill, 4 % consisted of half-basket weave attached to the edge of sword sheaths (grave 35 at Holubice) and an indeterminate kind of fabric adhering to a leaf-shaped lance head (grave 16 at Blučina, Fig. 6). The remaining 20 % of the fragments could not be more closely characterised.

Textiles of flax (25 %) and wool (24 %) predominated this collection; 2 % were of hemp and 49 % remained impossible to identify.

An interesting find comes from grave 56 at Holubice, where two recognizable cloth types were attached to an iron fibula. On a fine z/z tabby, which has a thread count 18/15, lies a coarser plain twill fabric with around 8/8 thre-

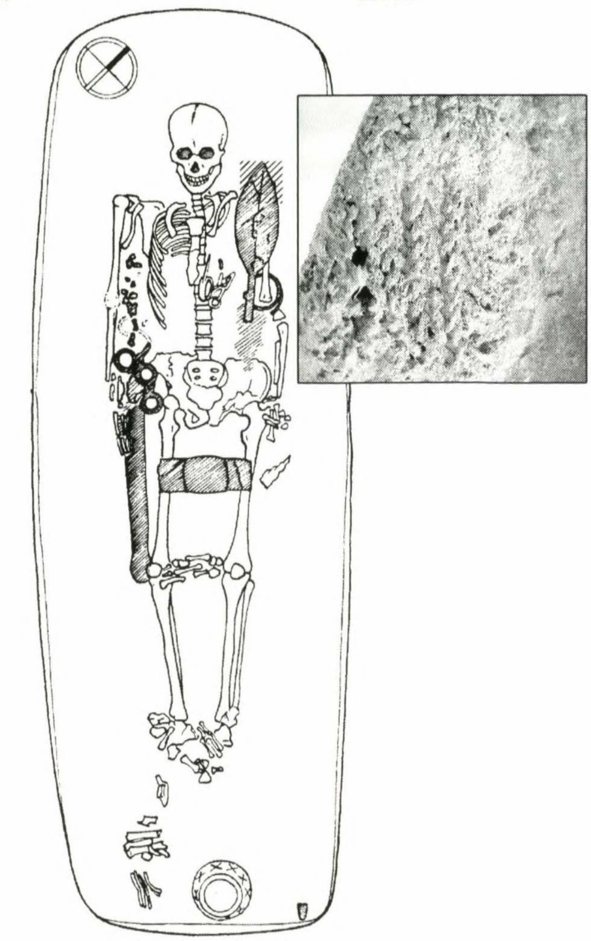

Fig. 6: Blučina, warrior grave 16: Detail of a fabric adherent on the edge of leaf-shaped lance head (based on V. Podborský et al. 1993, photo by author).

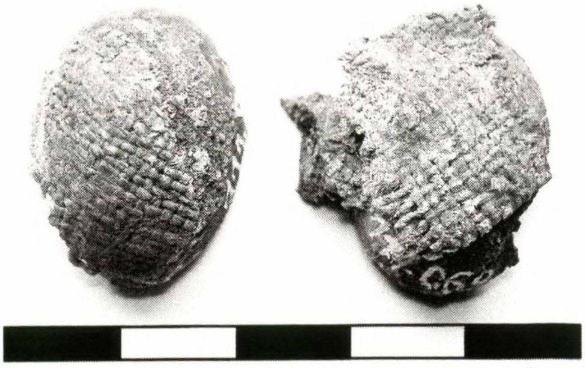

Fig. 7: Křenovice, double grave 17: Piece of linen tabby covering two semi-globes of bronze anklet (© Tereza Belanová).

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[18] Pieta 1992: 57, translated by author.

[19] J. Opralová, archives of Archaeological Institute Nitra, nr. 10.779/84 and 12.016/87.

[20] Pieta 1985: 65 and J. Opralová, archives of Archaeological Institute Nitra, nr. 10.414/83.

[21] Bujna 1995: 73, tab. 36:4,5.

[22] Most of the analyses were made by the author recently, as well as longer ago by L. Bender Jørgensen and M. Kostelníková.

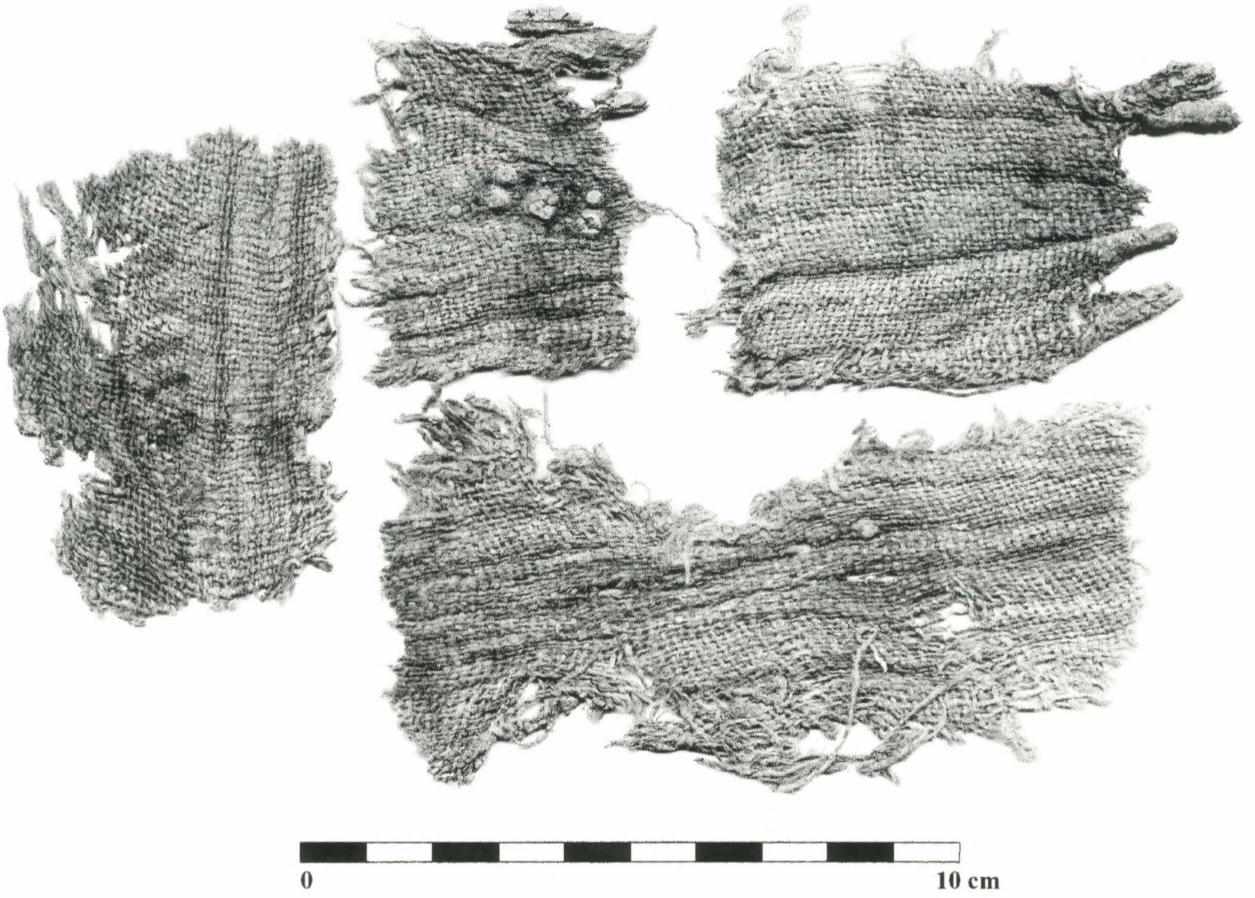

Fig. 8: Brno-Maloměřice, grave 48: Pieces of textile fragments in z/z linen tabby, taken out of bronze sheet anklets (© Tereza Belanová).

ads per cm. Due to corrosion, unfortunately, the fibre could not be closely identified. A fragment of walnut-shaped knobbed anklet, placed next to the ankle of the deceased, with a nice piece of linen tabby (thread count around 13/13) was attached on two semi-globes of the anklet in the double grave 17 at Křenovice[23] (Fig. 7).

As in the case of the Slovak finds, textile fragments recovered from bronze anklets in Moravia are larger and well preserved. Textiles were found in a pair of anklets from two female inhumation graves 48 and 67, which come from the largest Moravian La Tène graveyard at Brno-Maloměřice[24].

Four tattered fabrics were found in two anklets from grave 48 (Fig. 8). They are all green due to patina, dusty and slightly folded. Impressions of the inner side of the anklet are still visible on some of the pieces. Neither starting border nor selvedge nor stitch-holes have occurred. These four fragments are z/z linen tabbies, having a count of 12-14/9-10 per cm with the thickness of threads 0.6/0.8 mm. Since the same features can be recognised on all four pieces, it may be assumed, that they originally came from one bigger piece.

A larger assemblage comes from grave 67. Several pieces of green and slightly folded fabric in z/z linen tabby, some very tattered, were observed. The first anklet contained three pieces, which the thread count varied 12-16 in warp, 12-14 in weft and the thickness of threads was 0.5-0.7 mm (Fig. 9). On some small fragments selvedges are visible. One bigger piece shows several stitch-holes situated in a row, at right angles to the direction of folding. The following group of textile fragments coming from another anklet seem to be very similar (Fig. 10). Thread count is in some parts denser in warp (16-18) and the same in weft (12-14). Threads are from 0.3 to 0.6 mm thick. Across half of the width of one significant piece stitch-holes run in a row and a simple hem is visible in one end. It looks as if in both cases the cloth was originally stitched into a fold through the holes, by a different kind of thread, which had already vanished. Though there are some small differences in textile features among these fragments, they could originally be a part of one bigger piece.

Tattered textile fragments were also preserved inside the bronze anklet from grave 4 in a small graveyard at Nížkovice. They are in a very bad state of preservation, but basic features can be identified. Loose z/z tabby with a count of 7-12 threads in both systems and a thickness of 0.5-0.7 mm

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[23] This find is in older unpublished analyses identified as flax, but maybe hemp. The exact identification of the fibre is not clear from SEM analysis, but it seems to be more like hemp than flax (my thanks for help with SEM idenfication to A. Rast-Eicher).

[24] Poulík 1942: 70, 77. – Čižmářová 2004: fig. 74:11,13; 79:20,22.

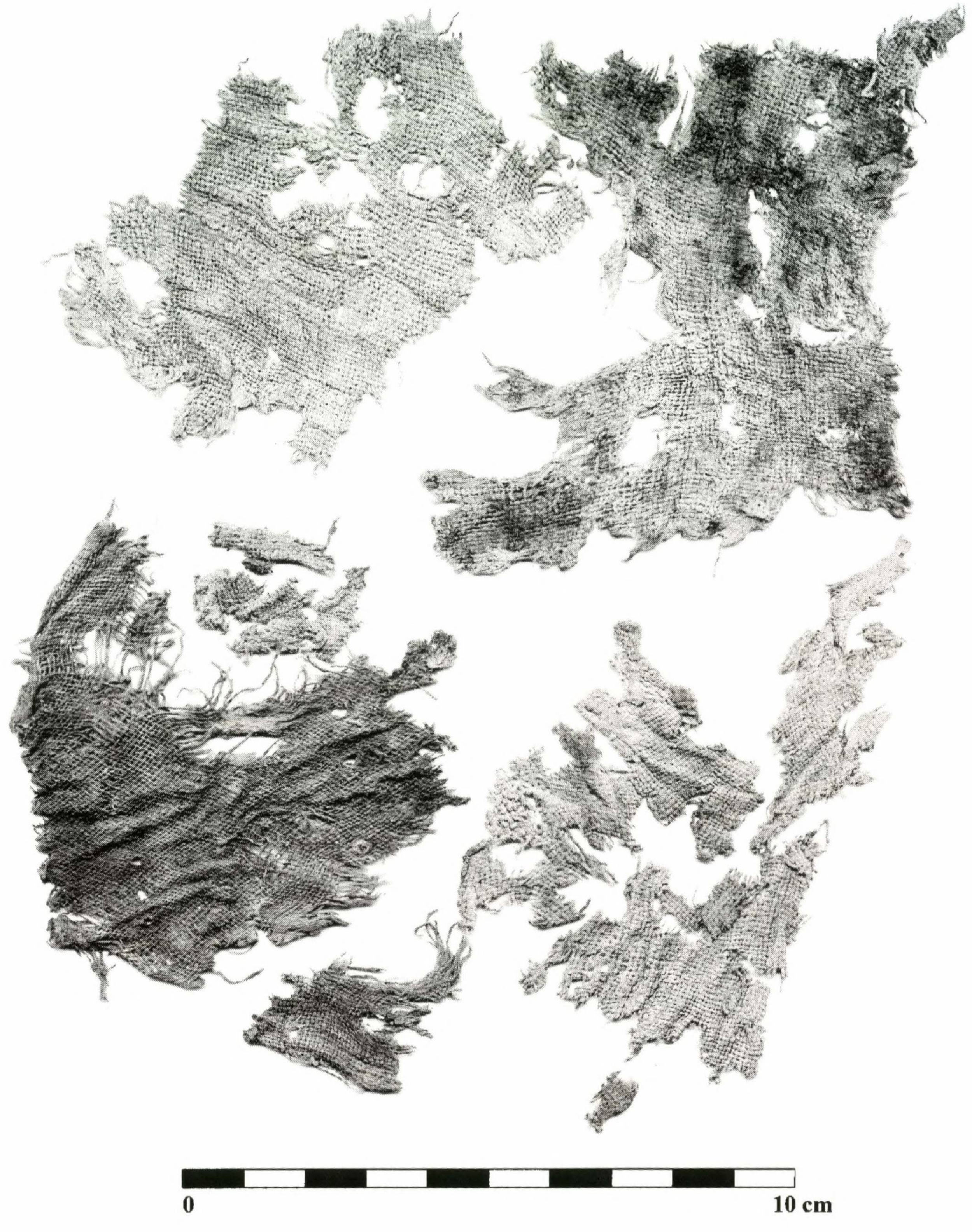

Fig. 9: Brno-Maloměřice, grave 67: Pieces of textile fragments in z/z linen tabby, taken out of bronze sheet anklets (© Tereza Belanová).

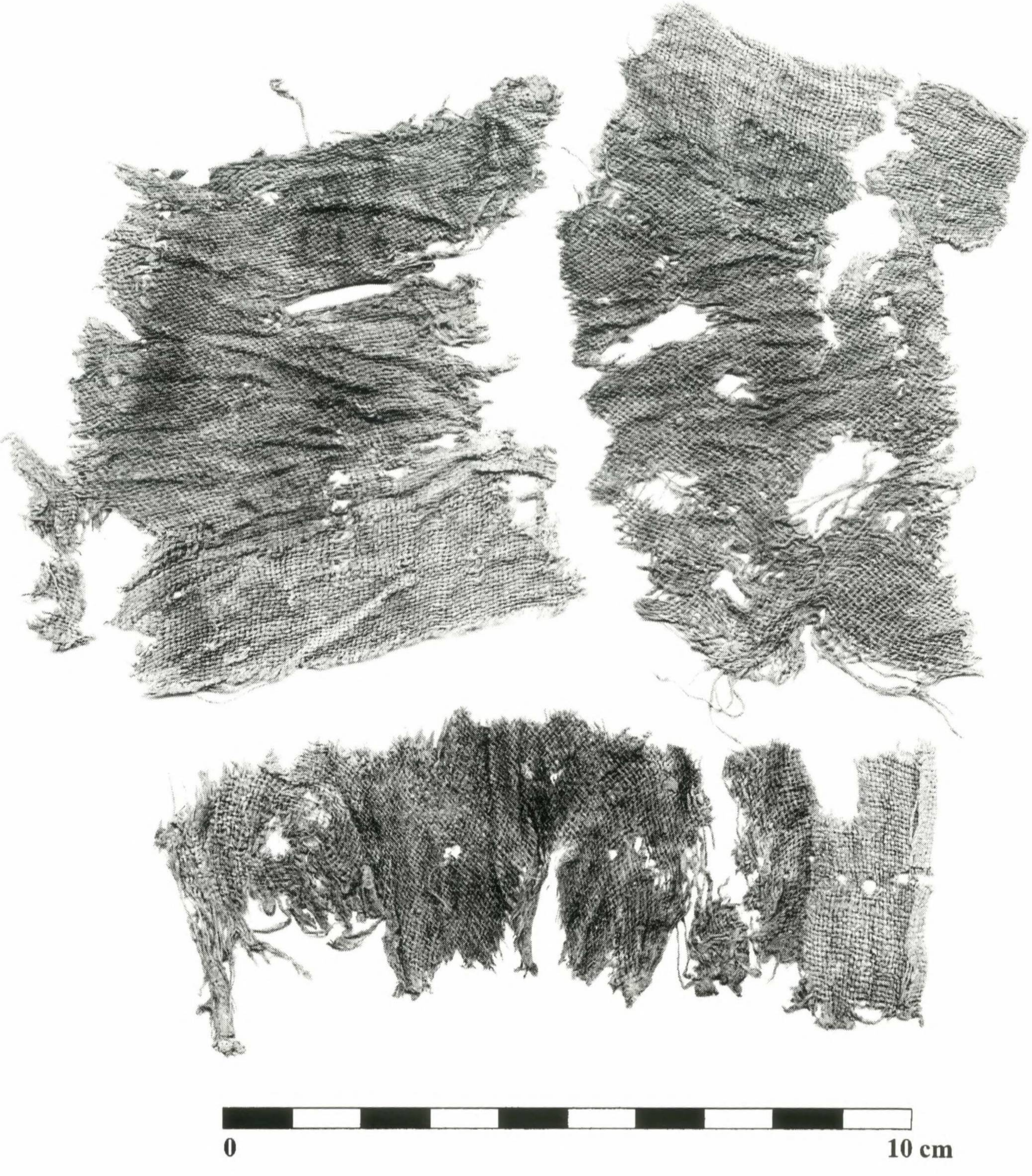

Fig. 10: Brno-Maloměřice, grave 67: Pieces of textile fragments in z/z linen tabby, taken out of bronze sheet anklets. Stitch holes and simple hem are visible (© Tereza Belanová).

can be recognized. Despite having several hardly perceptible selvedges, no stitch-holes, hems or seams were found. According to the oldest notes about this find the fabric is made of hemp[25]. Unfortunately, we could only identify the fabric as belonging to a plant fibre category.

Microscopic analyses

In addition to basic macroscopic analyses and descriptions of fabrics (weave, spin-direction, thread-count and thread-thickness) the definition of the raw material is essential, too (Fig. 11). By doing this the questions about what kind of material a given fragment was made of and what the features are of the fibre used are being addressed. To answer these questions microscopy analysis methods, mostly polarized light microscopy and scanning electron microscopy, have to be investigated[26]. The application of these studies in our research is only at the beginning, but we try to develop a suitable technique of fibre identification and develop a vital methodology for the microscopic examination of archaeological textiles.

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[25] Procházka 1937: 45.

All samples were first analysed by using a simple stereomicroscope to define basic textile features. Later single fibres were studied in polarized light and compared to the modern reference collection. Consequently the fragments and fibres were examined by SEM. Contamination ("dirt") and conservation agents covering the surface of fibres studied caused the biggest problem during both microscopic processes, and did not allow us to establish direct matches. The nodes, transverse cuts and natural ends of flax/hemp fibres in polarized light were clearly seen, but the distinction between flax and hemp was rather difficult (Plate 20). The scanning electron microscope offered more detailed study of the surface of the fibres. The possibility of undertaking a physical-chemical analysis of the fibre from Nížkovice, enabled us to detect and identify mineral components of contaminants ("dirt"), as well as mineral consistence of clean single fibre components – carbon and oxide (Fig. 12, 13). A closer look at bundles of fibres and nodes of single fibres was possible too (Fig. 14) and in some cases retted or fresh fibres could be distinguished.

Results and discussion

Slovak and Moravian La Tène archaeological textiles show very similar features and no striking differences were observed. Furthermore this collection is comparable to well-examined finds from cemetery and salt-mines at Dürrnberg near Hallein.

Plain linen tabby of z/z spin direction predominates. As research on Central European textiles in last two decades has shown, this combination prevails in the eastern area of distribution of La Tène culture[27].

The replacement of 2-ply yarn by single yarn during the La Tène period as recorded in other parts of Europe, a turning point of textile production[28], is also attested in our material. The change relates to the introduction of summer-annual flax which enabled the spinning of single yarns. i.e. to weave finer cloth[29]. This change is sometimes also associated with climatic change to dry and warm weather, which reached Central Europe by 300 BC[30]. Though we do not have much evidence of hemp fabrics, it is likely that they were commonly produced. Hemp seeds were identified in several Late La Tène contexts from the territory of Slovakia [31].

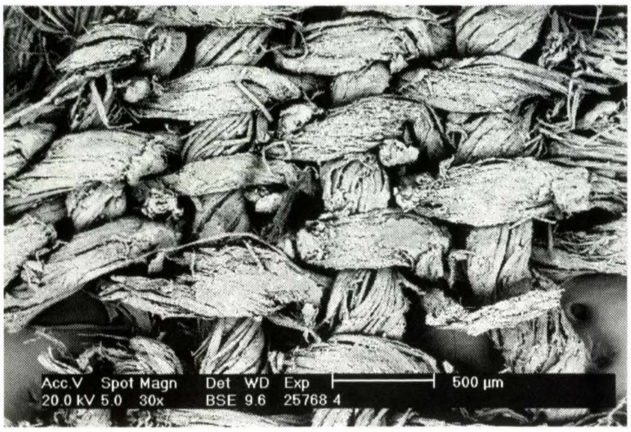
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Fig. 11: Nové Zámky, grave 9: Detail of tabby weave, x30 (© D. Janová 2004) .

The most notable difference between the Slovak and Moravian collection is evinced in the use of wool. Within the Moravian assemblage, the ratio of woollen to linen textile fragments is almost the same. In contrast the Slovakian assemblage lacks the wool fibres completely. Moravian woollen fabrics attached to iron weaponry were coarser than the other finds. The date on Slovak finds of such a character show the same trend. However, the absence of woollen thread in the Slovak material could be partly due to the state of research, and its occurrence in the future is probable.

Geographically the closest analogous example to these fragments can be found in the Early and Middle La Tène cemetery at Jenišův Újezd (Bohemia) with only woollen textiles[32]. Coarser z/z tabbies were attached to iron swords; finer twills and tabbies were associated with fibulas, anklets, bracelets and other supplements to clothing. Similar

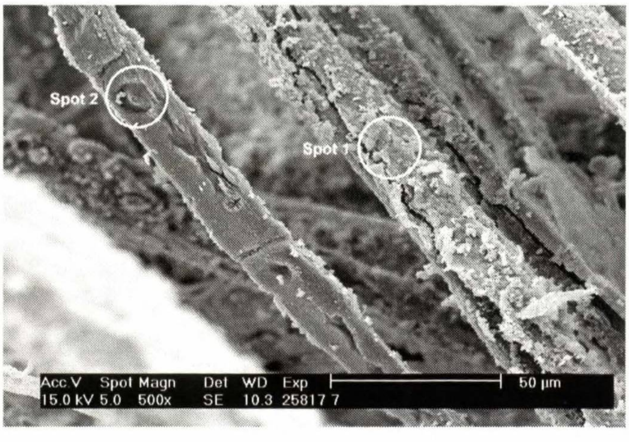
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Fig. 12: Nížkovice, grave 4: The surface of single fibre, x500. Dirt and conservation products can be seen on

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[26] For these analyses were applied: stereomicroscopes x40 and x150, polarized light microscope x400 and scanning electron microscope (SEM), max x10000 .

[27] Bender Jørgensen 1991, 1992. – Pieta 1992.

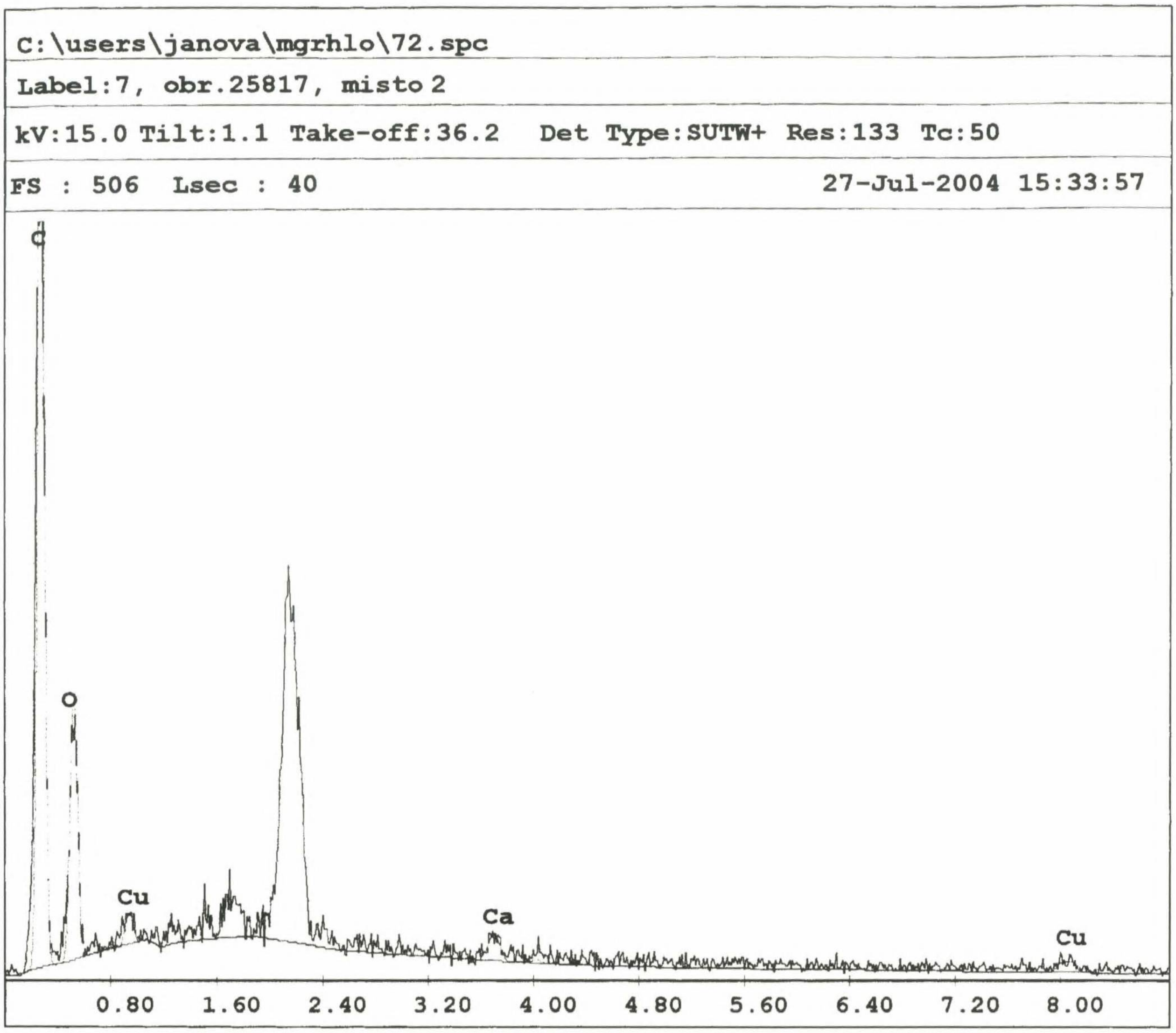
[28] Bender Jørgensen 1992: 125.

[29] Helbæk 1959. – Körber-Grohne 1987. – After Bender Jørgensen 1992: 125.

[30] Crumley 1995: 128.

[31] Bratislava-Devín, Púchov-Skalka and Liptovská Mara – E. Hajnalová 1999: 69 and M. Hajnalová – personal communication.

[32] Kostelníková 1978: 225-228. – Waldhauser 1978: 228-230.



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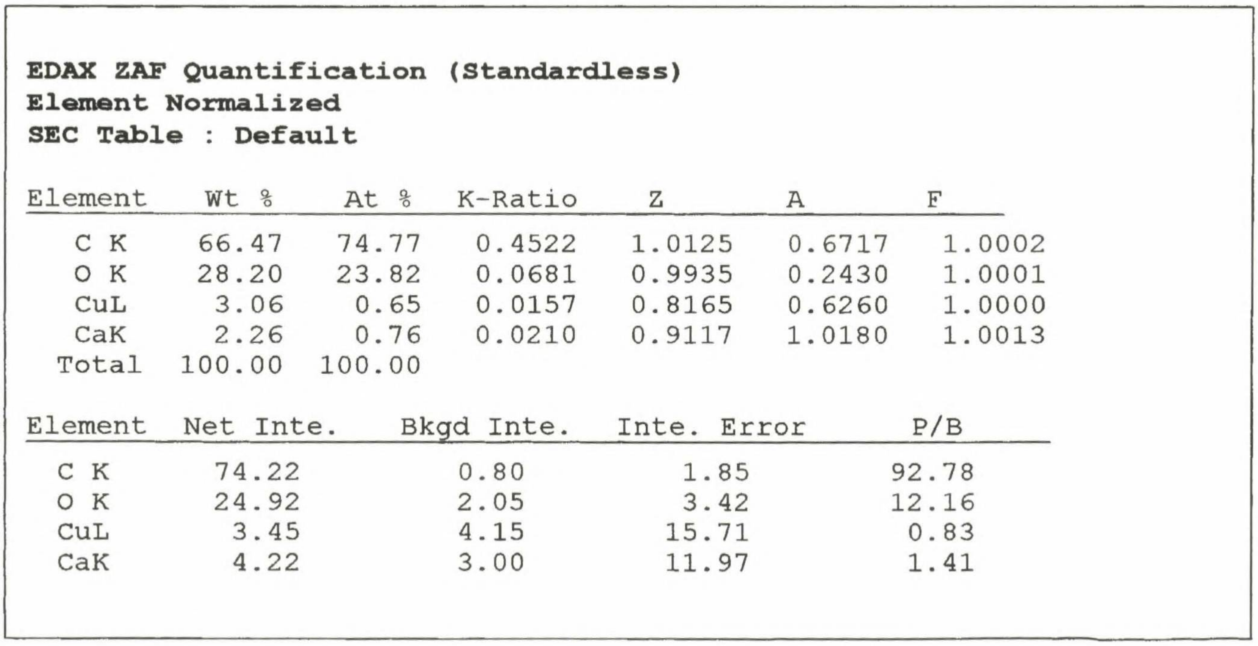

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EDAX ZAF Quantification (Standardless)
Element Normalized
SEC Table : Default

Element    Wt %     At %   K-Ratio      Z          A          F
   C K    66.47    74.77   0.4522   1.0125    0.6717    1.0002
   O K    28.20    23.82   0.0681   0.9935    0.2430    1.0001
   CuL     3.06     0.65   0.0157   0.8165    0.6260    1.0000
   CaK     2.26     0.76   0.0210   0.9117    1.0180    1.0013
 Total   100.00   100.00

Element   Net Inte.    Bkgd Inte.   Inte. Error       P/B
  C K       74.22          0.80         1.85          92.78
  O K       24.92          2.05         3.42          12.16
  CuL        3.45          4.15        15.71           0.83
  CaK        4.22          3.00        11.97           1.41
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spot 1. Spot 2 shows the fibre, from where psysic-chemical analysis was made (© D. Janová 2004).

finds were recently recovered in some other Bohemian graveyards of the La Tène period, including textiles from bronze tubular anklets[33].

The original function of the textiles recovered from graves is hard, but important to define. In general, finer fabrics are found with jewellery and other accountrements of clothing: fibulas fastened a dress; fabrics attached to bracelets and anklets may come from individual parts of clothes (sleeves, skirt and mantle) or a shroud. As for the warrior graves, the deceased was buried in his full costume, which could include other items of his equipment.

To be able to make more detailed interpretations of the finds and reconstructions of particular pieces of garments a database containing a variety of information is needed. Exact identification of textile fragments in graves and determination of their function depends largely on the primary and basic documentation, made during the recovery of the finds directly in the field.

As ethnographic studies show it is not only natural environment and climate which influenced the use of particular materials. Cultural factors such as fashion and a preference for certain materials, patterns and decoration are equally important. Probably it was not much different in prehistory. There are (and were) practical reasons, but the function of dress in pointing to the status of its wearer within society is (and was) important.

As for the secondary use of textiles, like the ones recovered from bronze anklets, it is necessary to say that a textile was a valuable artefact and therefore utilized for a very long period of time, often until it almost fell apart. It is clear that the steps from spinning the threads to weaving a certain amount of fabric must have taken much energy and time. Hence, as the historical and ethnographic sources show, the final product came through several different levels of use – from the festive and everyday one to worn-out piece, ultimately used by other crafts or in a different context.

The technology of weaving in the La Tène period is based upon the warp-weighted loom. This fact is supported by finds of loom-weights and spindle-whorls distributed at settlements. These secondary sources, including partial impressions on pottery, will be dealt in further research. A reconstruction of a La Tène warp-weighted loom was made in 2004 for an archaeological exhibition "The Celts at Devín." Together with an ethnologist, the author gathered important sources of information needed for the construction of the loom. The textile fragments from Nové Zámky and Brno-Maloměřice were used as a model for thread-count, spin-direction, type of weave and raw material. This little experiment was very helpful for research and it is hoped that all planned reconstruction projects will move the research of La Tène textiles one step further.

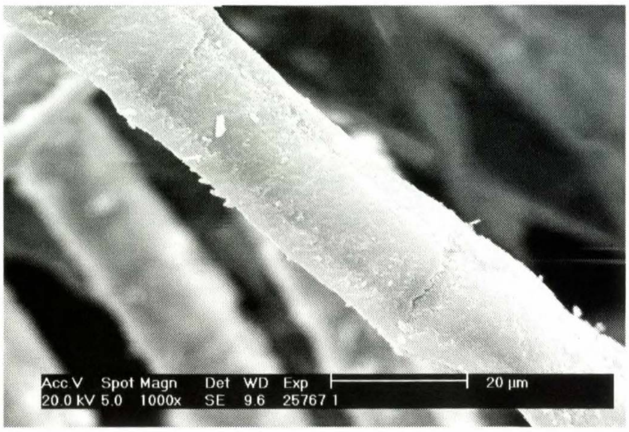
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Fig. 13: Nížkovice, grave 4: Spot 2, the results of psysic-chemical analysis of components of single flax/hemp

Summary and conclusion

Macro- and microscopic analyses of La Tène textile fragments from south-west Slovakia and southern Moravia (the adjacent region of the Czech Republic), were reviewed. It was recognised that all main textiles characteristics (spin direction, count of threads, their association with specific artefacts, etc.) show a very similar pattern across the region. The only striking difference is in the use of woollen textiles in the western part of the area studied. Their absence on the territory of Slovakia could to a large extent be a result of lack of focused research in the past.

New excavations are being more closely monitored and more attention is being paid to collecting a representative assemblage of textile finds on the territory under discussion. All accessible information about each fragment is being recorded. It is hoped that these new finds and the archaeological data collected will enable us to draw a more realistic picture of textile production and its role in prehistory and to correct contemporary highly biased results.

As was shown above, in view of the typical soil and climate conditions recovery of any larger pieces of textiles, or even complete clothes would be rather a surprise. On the other hand, many data regarding technical descriptions could be extracted even from tiny pieces of this sparse material. The deposition and recovery context of the find and its chronological and chorological determination have the capacity to provide very important archaeological information.

Monitoring of different kinds of traditional techniques by incorporating ethnographic methods, does help us to understand the role, function and evolution of textile production. Important, too, is the focus on advancing analystical methods of microscopy. The methodology and logistics of fibre identification must be enhanced and become a routine and active part of archaeological research in the region. Badly preserved textile pieces must be carefully treated, prepared for the analysis and either preserved for future research and/or presentation to public.

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[33] Sankot and Kurzynski 1994.

Even if our research is only at the very beginning, we do hope that it will help to solve many archaeological questions, not answered to date.

Zum Forschungsstand der latènezeitlichen Textilfunde aus der Slowakei und Mähren

Zusammenfassung und Ausblick

Gegenstand dieser Arbeit sind die latènezeitlichen Textilreste aus der Südwestslowakei und Südmähren, bei denen neuere makro- und mikroskopische Analysen durchgeführt wurden. Dabei ist auffällig, dass alle Hauptmerkmale der Textilien, etwa die Spinnrichtung (s- und z-Garne) oder die Gewebedichten ein sehr einheitliches Bild zeigen, ebenso wie die Vergesellschaftung mit spezifischen Artefakten. Der einzige herausragende Unterschied ist die Verwendung von Wolle im westlichen Teil des behandelten Gebietes, wobei das Fehlen von Textilien aus Wolle in der Slowakei auch forschungsbedingt sein kann.

Bei neueren Ausgrabungen wird ein größeres Augenmerk auf Textilreste gelegt, wobei versucht wird, jede mögliche Information über die aufgefundenen Fragmente zu dokumentieren. Diese neuen Funde und archäologischen Befunde werden es ermöglichen, ein realistischeres Bild der Textilproduktion und der Rolle der Textilien in der Urgeschichte zu zeichnen und veraltete Forschungsmeinungen zu korrigieren.

Wie in der englischen Langversion dieses Artikels gezeigt, ist die Erhaltung von größeren Gewebeteilen aufgrund der klimatischen Einflüsse ein Ausnahmefall, vollständige Gewänder kommen unter diesen Bedingungen nicht vor. Andererseits ist es aber auch möglich, allein aufgrund kleinerer Reste technische Detailbeschreibungen zu geben. Ebenso können aufgrund der Fundumstände und des Kontextes im archäologischen Befund, sowie durch die chronologischen und chorologischen Aussagemöglichkeiten interessante Informationen gewonnen werden.

Die Beobachtung verschiedener traditioneller enthnologischer Textiltechnologien kann helfen, die Rolle, Funktion und Entwicklung der Textilproduktion zu verstehen. Wesentlich für die Forschungsarbeiten sind aber vor allem die Fortschritte in den Analysemethoden in der Mikroskopie, um eine präzisere Faserbestimmung gewährleisten zu können. Zudem müssen schlecht erhaltene Gewebe sorgsam behandelt und konserviert werden, sowohl für spätere Forschungen als auch für eine etwaige Präsentation in einem Museum.

Obwohl die Forschungen zu den latènezeitlichen Textilien erst am Beginn stehen, so hoffen wir doch, bereits einige interessante archäologische Fragestellungen beantwortet haben zu können.

Acknowledgements

I am grateful to Dr. Juraj Zajonc (Institute of Ethnology, Slovak Academy of Sciences, Bratislava) for ethnological tuition, Dr. Karol Pieta (Archaeological Institute, Slovak Academy of Sciences, Nitra) and Dr. Jana Čižmářová (The Moravian Museum, Brno) for providing me with material, Asst. Prof. Jana Želinská (Academy of Fine Arts and Design, Department of Conservation Bratislava) for facilitating my work on the polarized light microscope, Martin Hložek M.A. (Institute of Archaeology and Museology, Faculty of Arts, Masaryk University) and Ing. Drahomíra Janová (Faculty of Mechanical Engineering, Brno University of Technology) for SEM analysis, Ing. Eva Hajnalová and Dr. Mária Hajnalová (Archaeological Institute, Slovak Academy of Sciences, Nitra) for valuable information and laboratory equipment.

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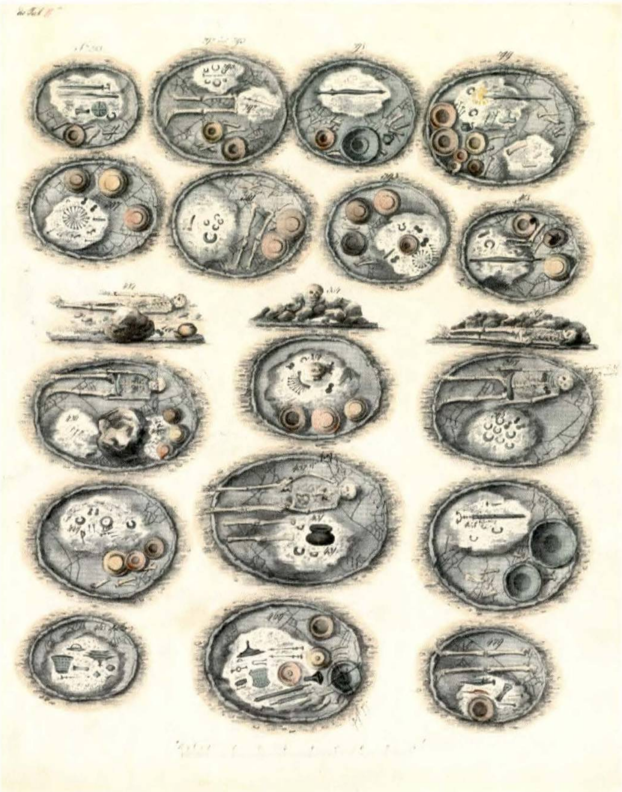
Curriculum vitae

Tereza Belanová (born 1977) received her M.A. in archaeology (2002) at Comenius University in Bratislava (Slovakia). Her diploma work was focused on textile production (*The Evidence of Textile Production in East-alpine Hallstatt Area. Possibilities of Utilization of Exact Analythical Methods in Archaeology*).
Since 2003 she has been working on her PhD at the Archaeological Institute of the Slovak Academy of Sciences in Nitra (Slovakia). Her main research interests are evidence of textile production in later prehistory and interdisciplinary approaches to archaeology. She is carrying out a research project on archaeological textiles. It is aimed (via interdisciplinary cooperation with ethnologists, conservators and other specialists) to reconstruct prehistoric, as well as early medieval textile production in the Middle Danube area and define its role in past societies.



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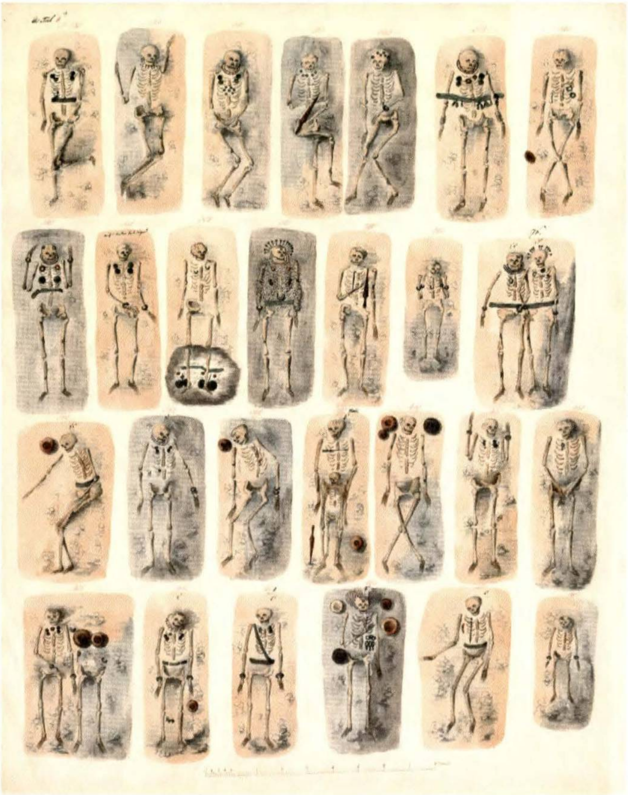

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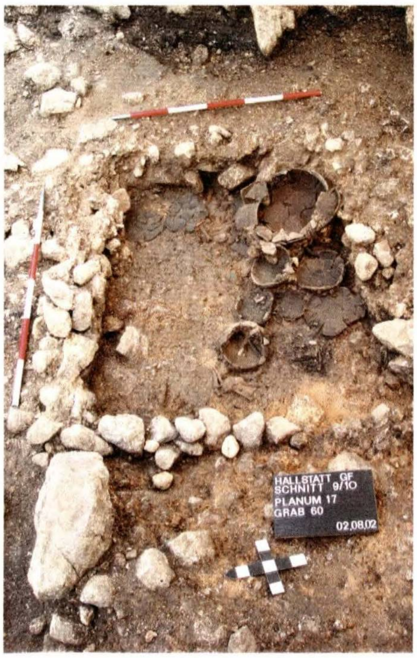
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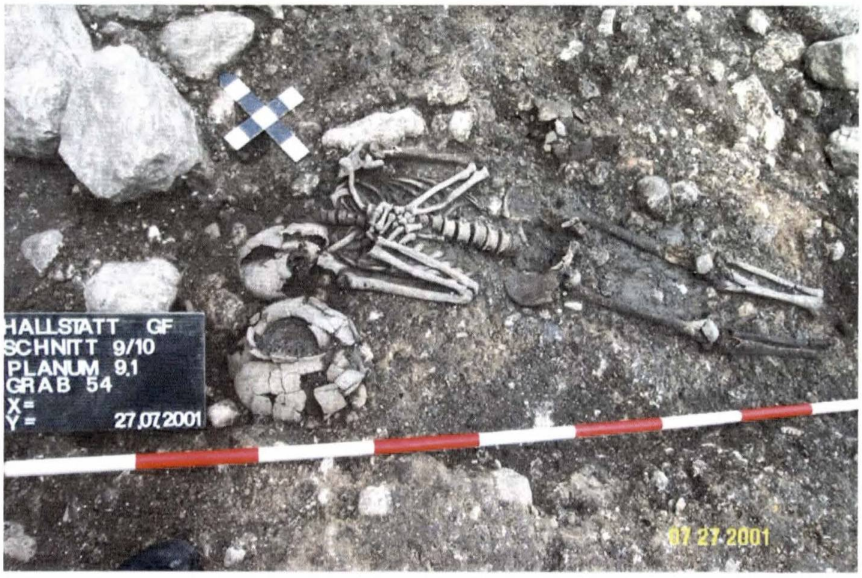
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Plate 1: Hallstatt: 1: Aquarell aus Ramsauer Fundprotokoll, Tafel 1a Körperbestattungen. – 2: Aquarell aus Ramsauer Fundprotokoll, Tafel 2a Brandbestattungen. – 3: Brandgrab einer Frau, Nr. 60 (2002); Brandschüttungsgrab mit Steinumfassung und 8 Proviantgefäßen, flach gedrückte Tongefäße im hinteren Teil des Grabes gehören bereits zur nächsten Bestattung.–- Körpergrab einer adulten Frau, Nr. 54; in einer von der Norm abweichenden Nord-Südlage (normalerweise West-Ost); ein großes Proviantgefäß an der rechten Schulter
(© Naturhistorisches Museum Wien, Prähistorische Abteilung).

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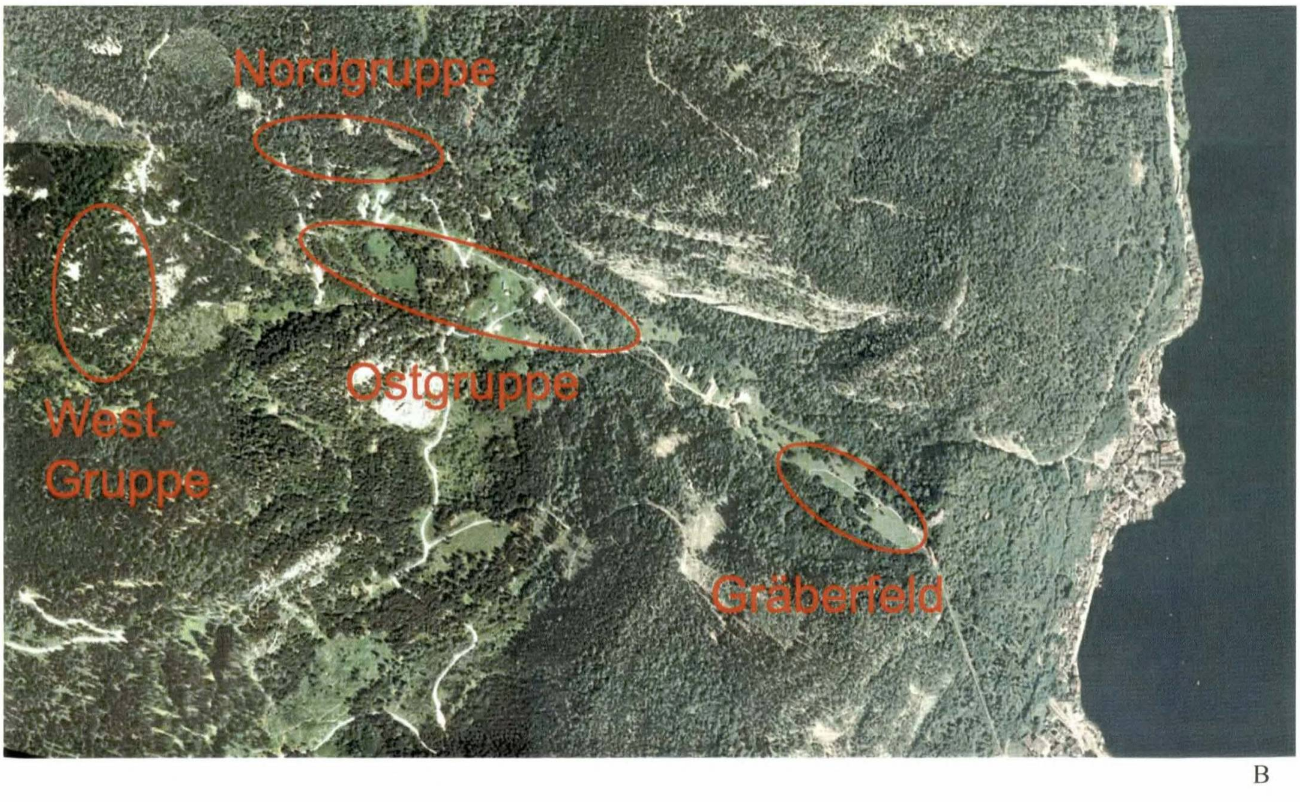


B

Plate 2: A: Der Ort Hallstatt am Hallstättersee und das darüber liegende Hochtal. – B: Luftbild von Hallstatt mit dem Areal des bronzezeitlichen (Nordgruppe), des hallstattzeitlichen (Ostgruppe) und des keltischen (Westgruppe) Bergbaues und dem hallstattzeitlichen Gräberfeld (A: © Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter. – B: mit freundlicher Genehmigung DORIS – Digitales Oberösterreichisches Raum-Informations-System).

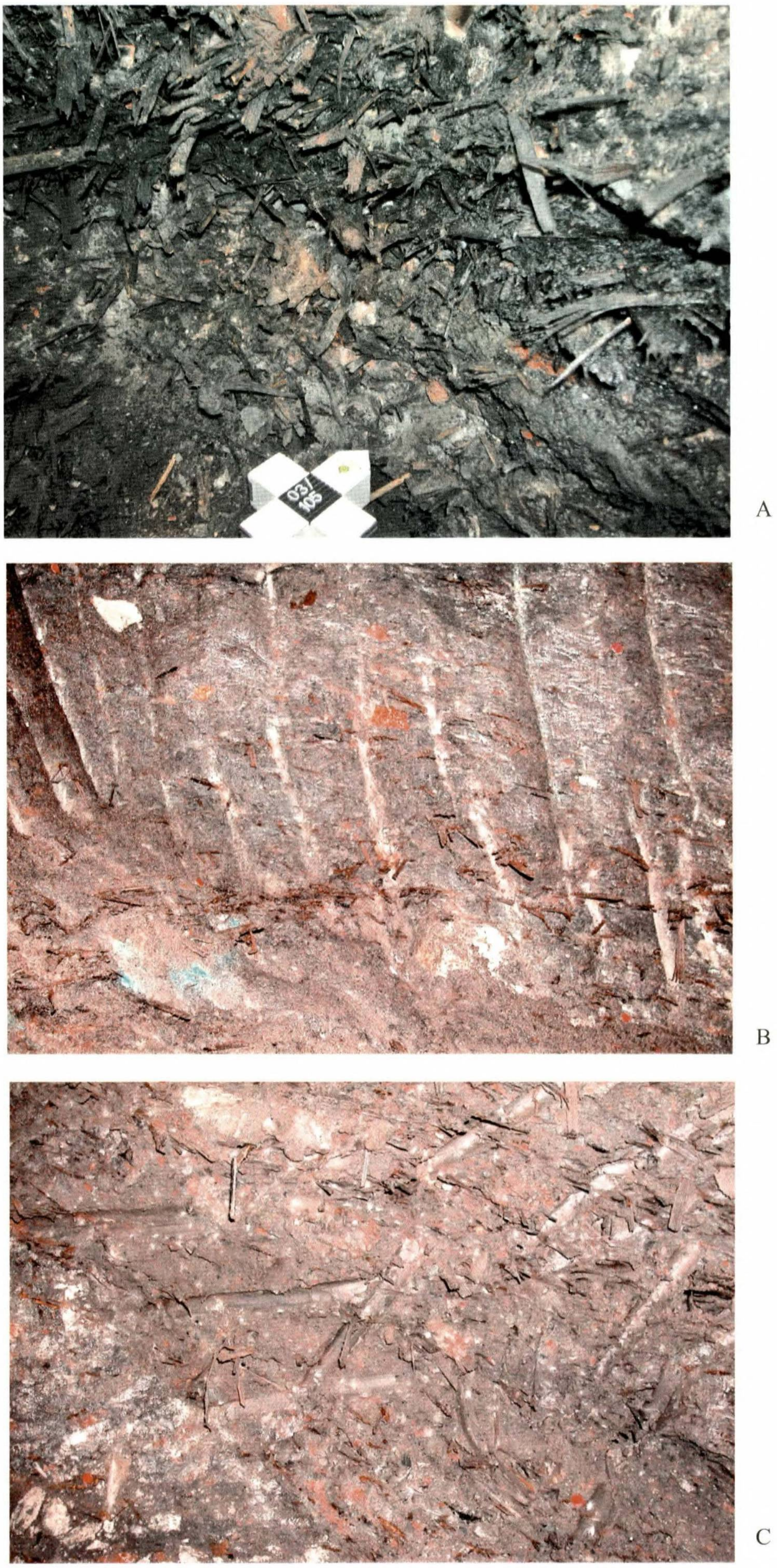


Plate 3: Hallstatt Salzbergwerk: A: Bronzezeitliches Heidengebirge aus dem Christian-Tuschwerk alter Grubenoffen. – B: Kerniges Heidengebirge aus dem Kilbwerk. – C: Verlaugtes Heidengebirge aus dem Kilbwerk (links unten unverlaugtes kerniges Heidengebirge) (© Naturhist. Museum Wien, Prähist. Abteilung. A: K. Kowarik. – B und C: A. Rausch).

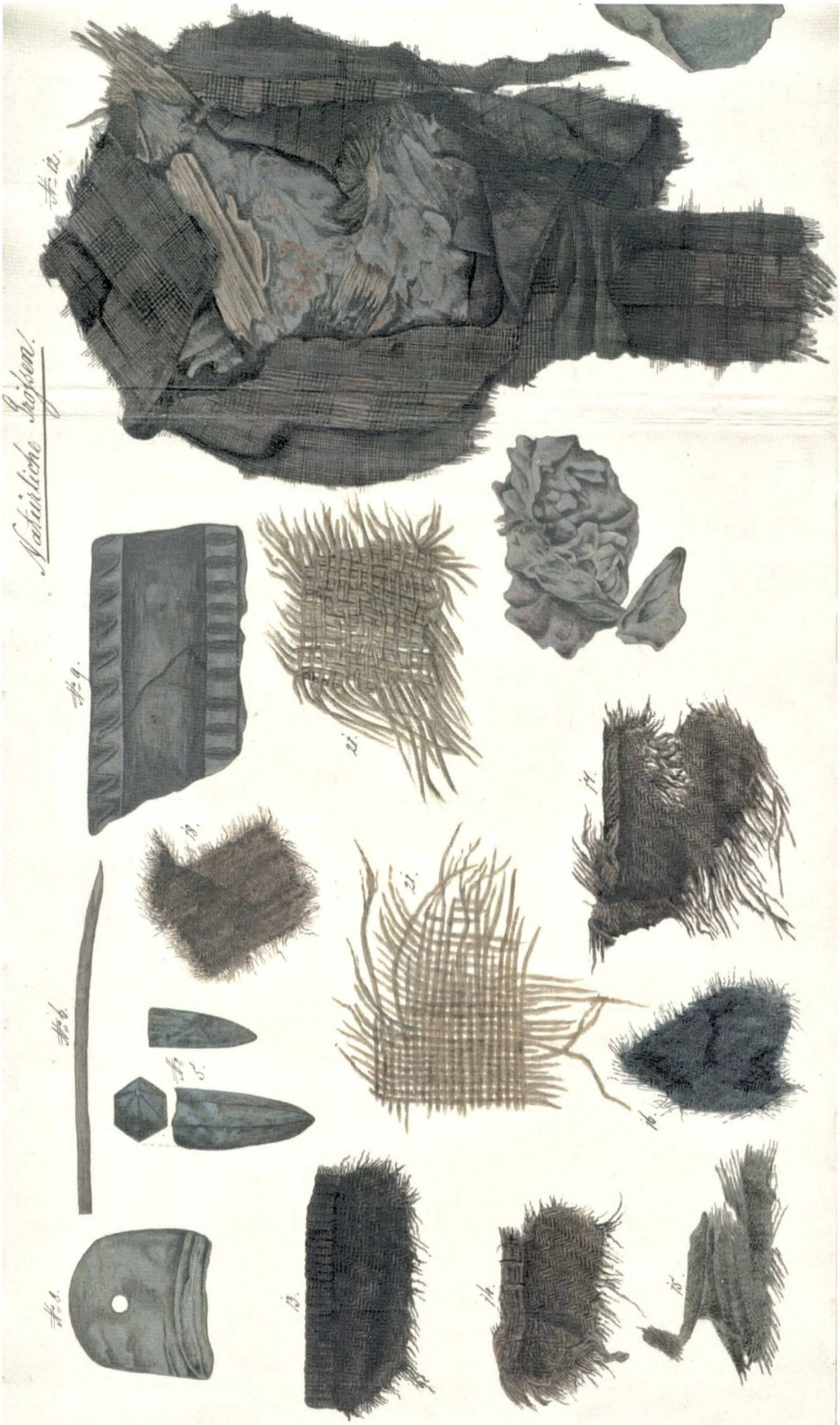
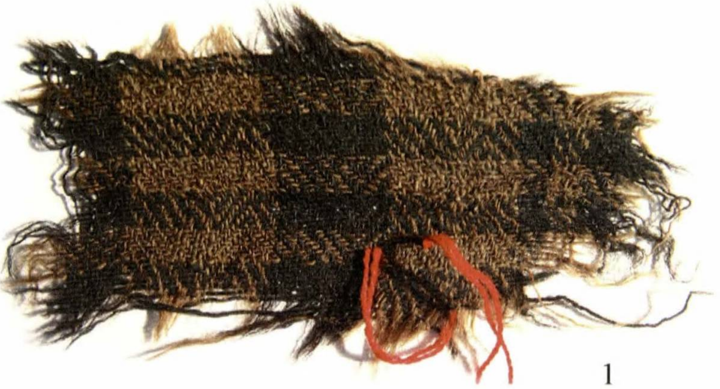


Plate 4: Hallstatt salt-mines: Tabula III from the report of J. G. Ramsauer containing illustrations of textiles (detail). Watercolour from I. Engl. *Tabula III des Berichts von J. G. Ramsauer aus dem Jahre 1850 mit Bildern von Textilien (Ausschnitt). Aquarell von I. Engl* (© Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter).



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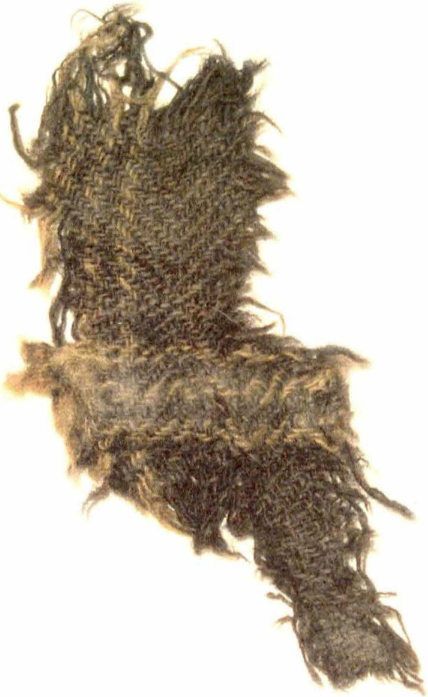

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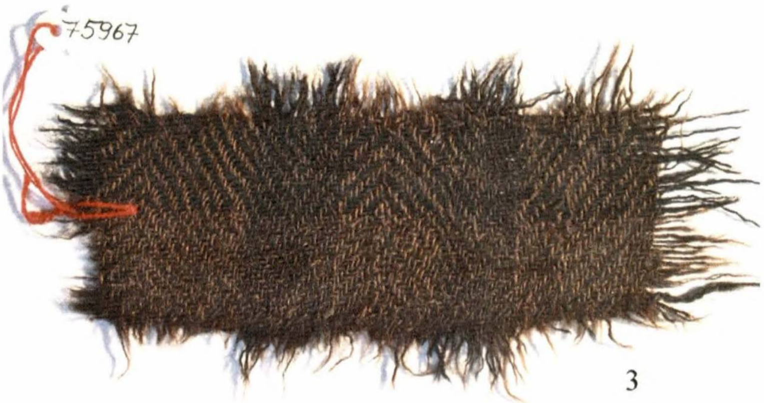

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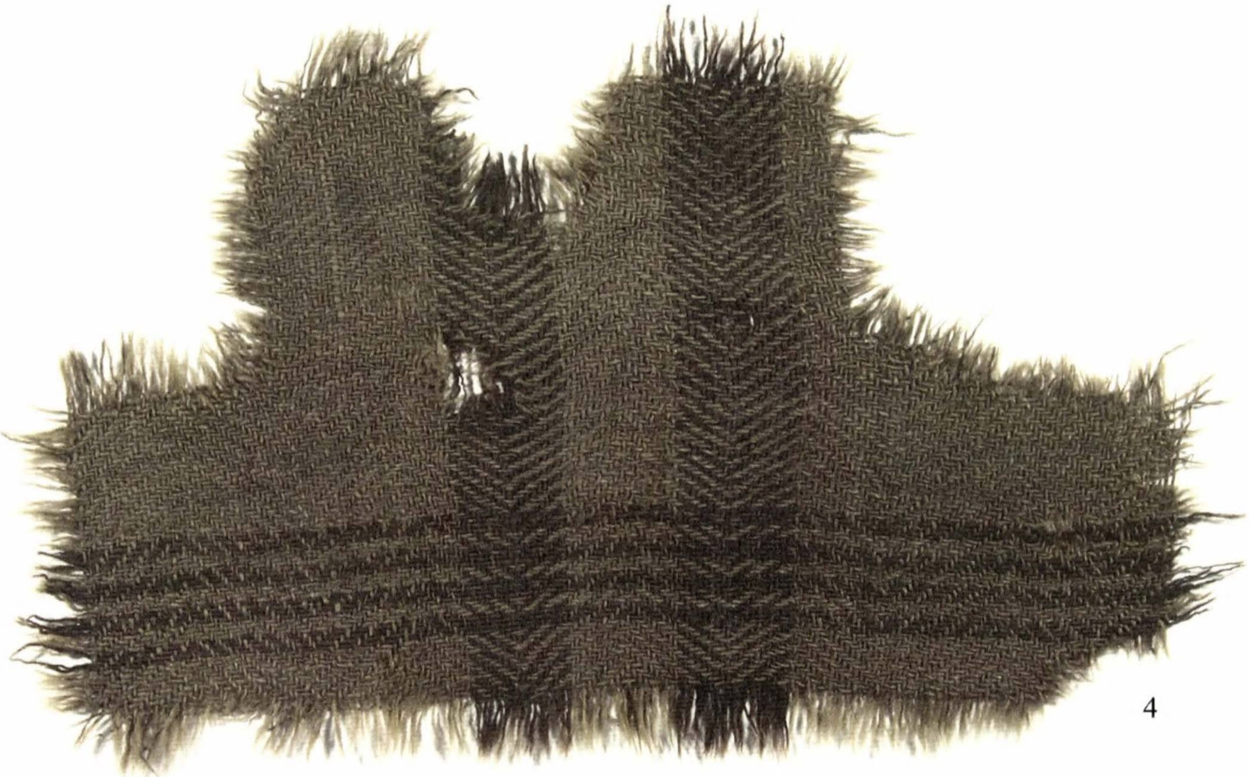

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Plate 5: Hallstatt salt-mines: checkered patterns from the Hallstatt period. *Karierte Stoffe aus dem hallstattzeitlichen Bergwerk.* 1: Inv. No. 78.552c. – 2: Inv. No 90.182. – 3: Inv.No. 75.967a. – 4: Inv.No. 75.973. (© Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter).

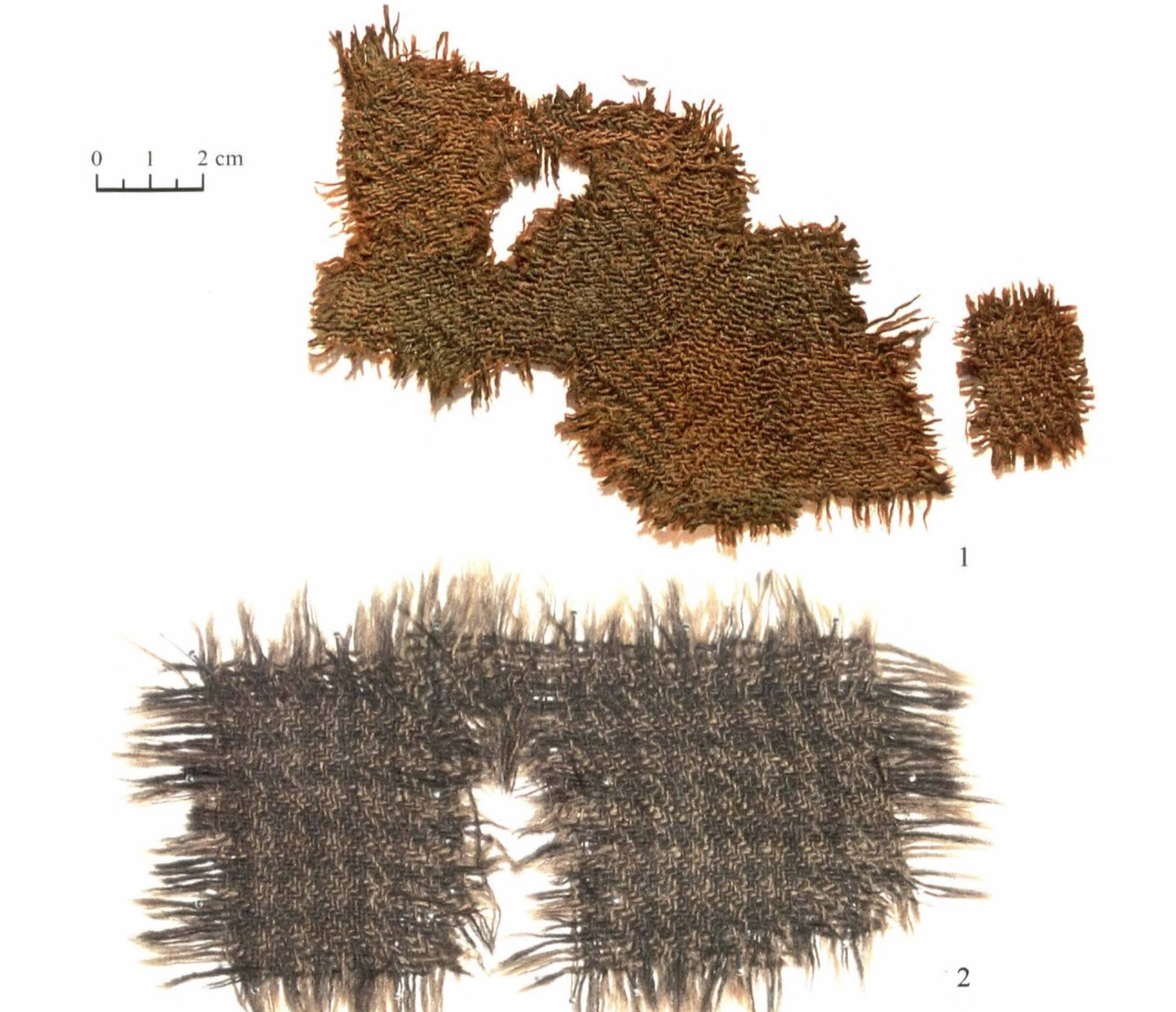
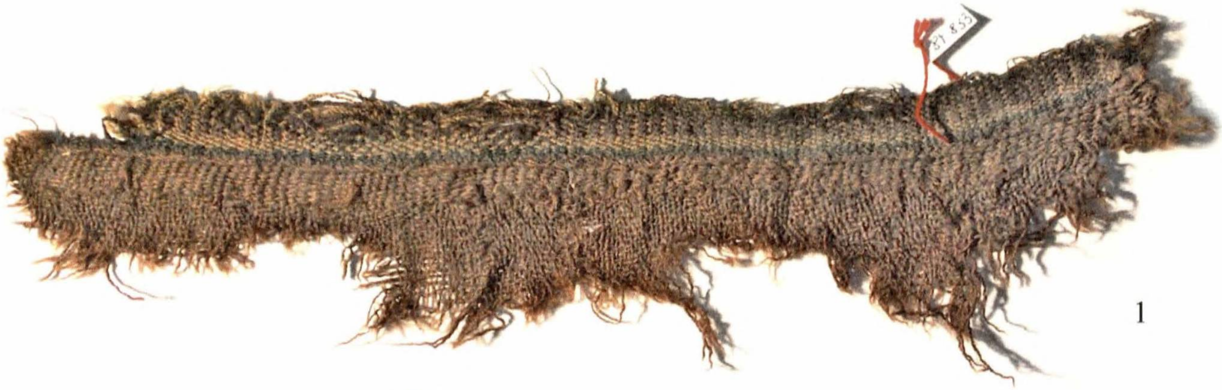


Plate 6: Hallstatt salt-mine: various patterns. *Verscheidene Muster*. 1: Inv. No. 75.891. – 2: Inv.No. 75.977. – 3: Inv.No. 89.718. – 4: Inv.No. 79.153 (© Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter).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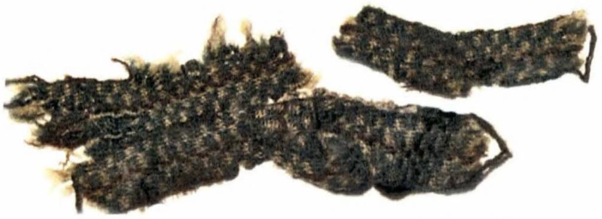
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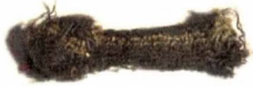
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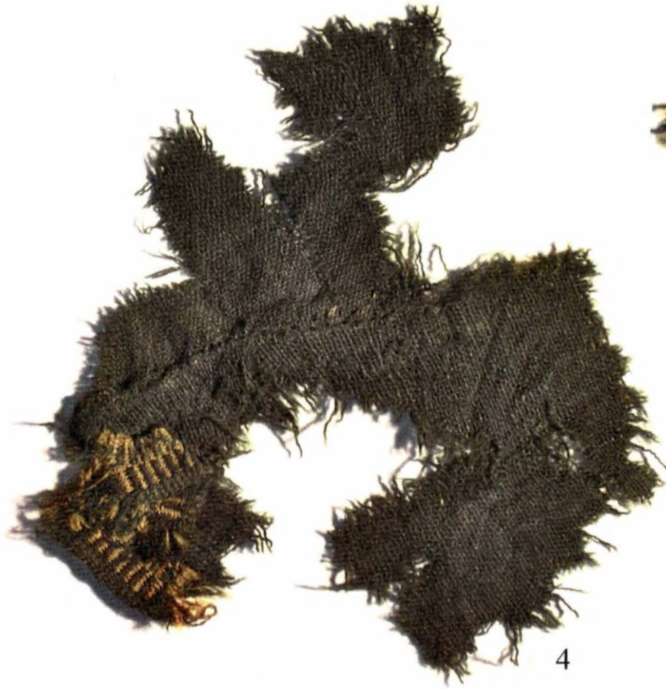
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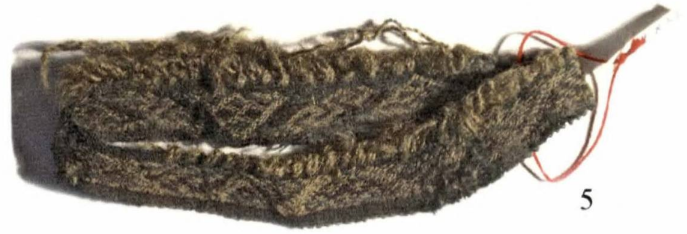
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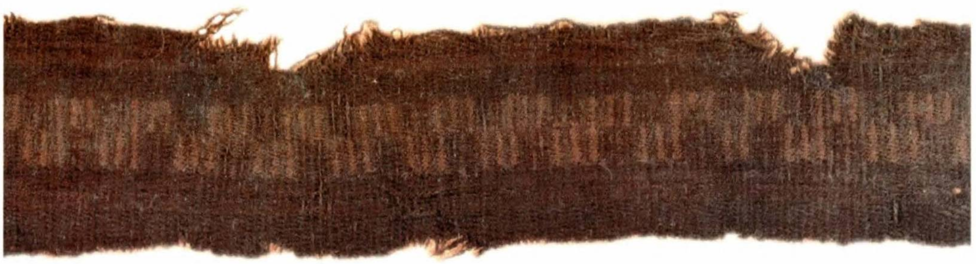
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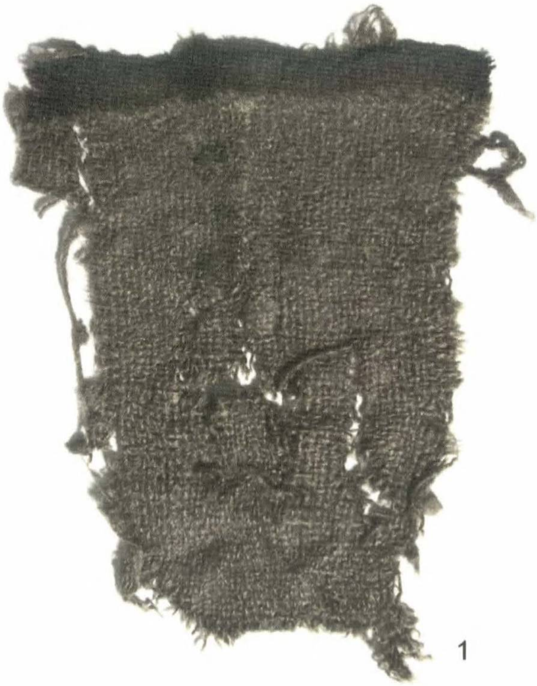
Plate 7: Hallstatt salt-mines: various coloured ribbons in tablet weaving and band weaving from the Early Iron Age *Verschiedene Bänder in Brettchenweberei und Gitterweberei aus der Älteren Eisenzeit.* 1: Inv. No. 89833. – 2: Inv. No. 90.180. – 3: Inv. No. 89.842. – 4: Inv. No. 79442b. – 5: Inv.No. 89.832. – 6: Inv. No. 73.345 (© NHM Wien, Prähist. Abteilung).



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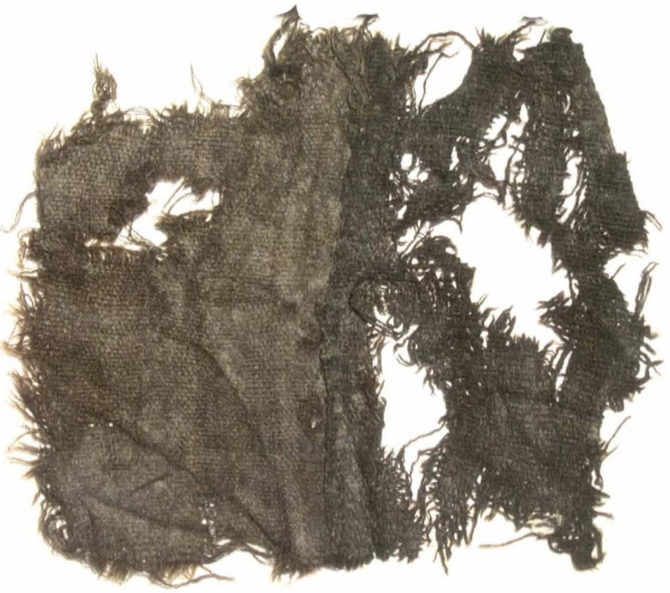

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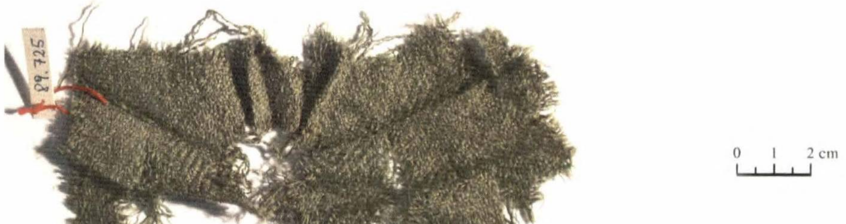

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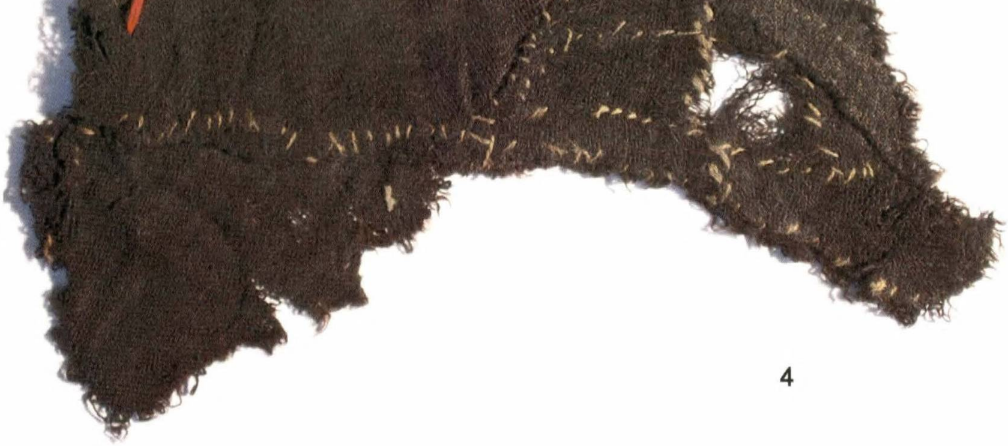

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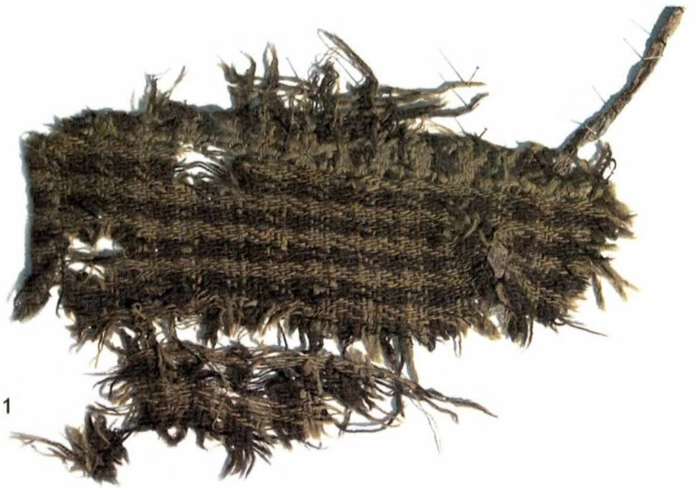
Plate 8: Hallstatt salt-mines: 1: textile with loops on one side and ribbon sewn on. *Gewebe mit Schlaufen auf einer Seite und angenähter Borte*, Inv.No. 90.067. – 2: tabby and basket-weave sewn together. *Leinenbindung und Panama zusammengenäht*, Inv.No. 90.126. – 3: herringbone twill fabric. *Fischgrätköper*, Inv.No. 89.725. – 4: patched fabric. *Geflicktes Gewebe*, Inv.No. 79.436 (© Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter).



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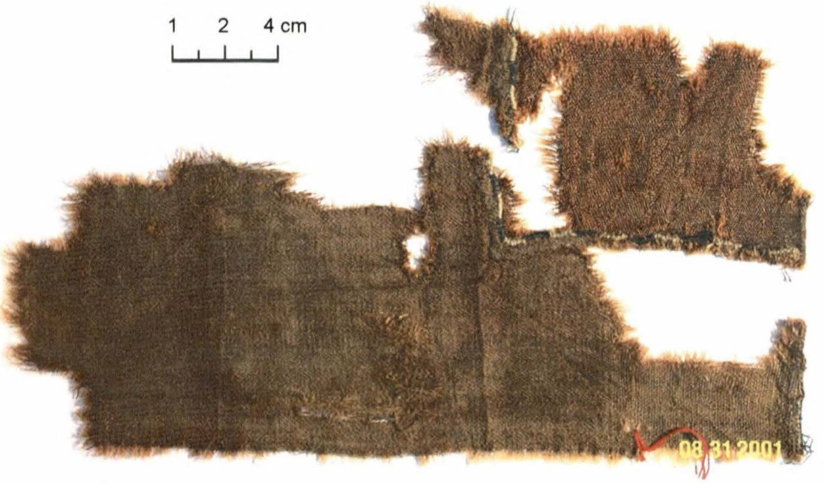

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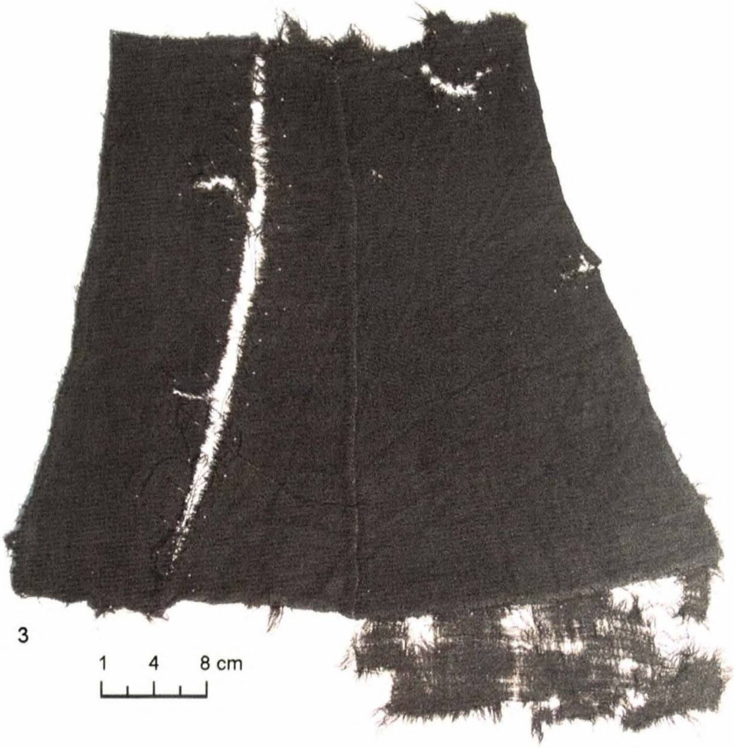

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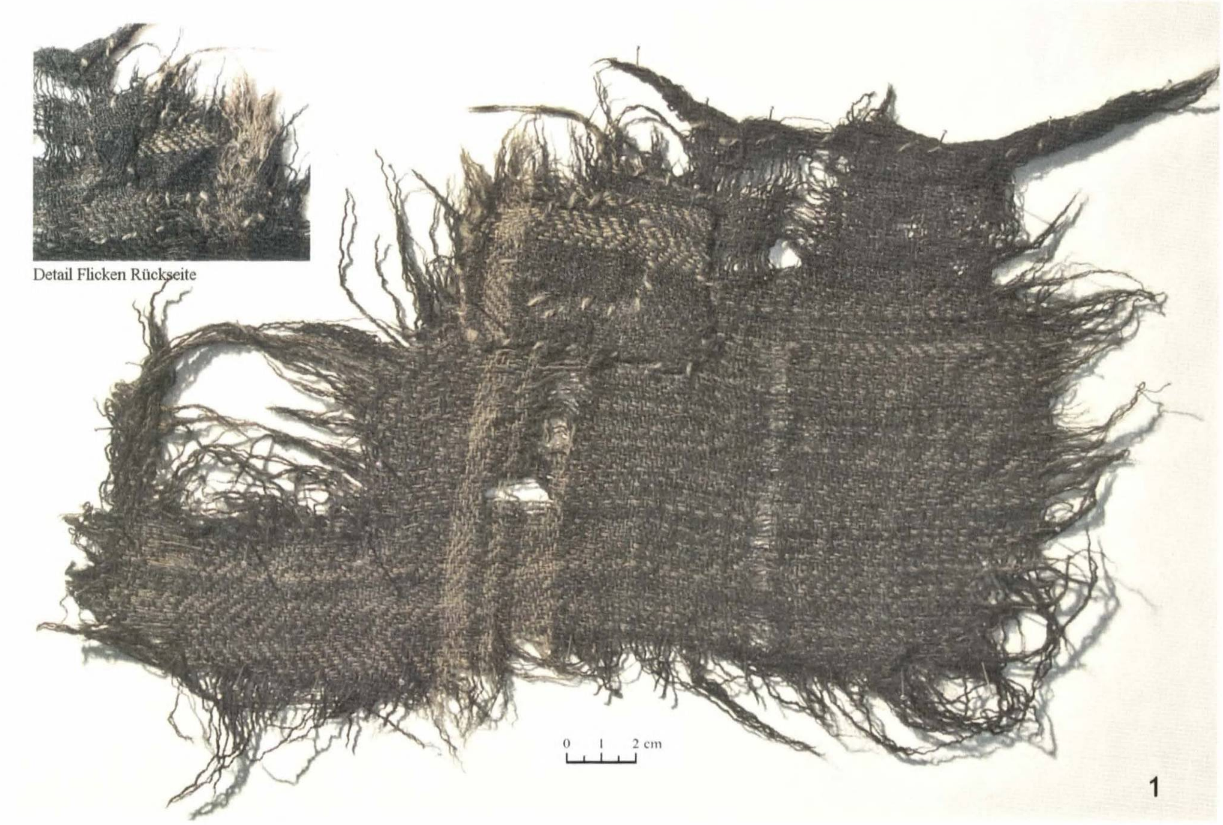
Plate 9: Hallstatt salt-mines: 1: Fell seam meets Hem. *Textil mit Naht normal auf Saum*, Inv.No. 73.344. – 2: Rectangular patch and seam with white and blue colour. *Textil mit eingesetztem Rechteck und zweifarbiger Ziernaht*, Inv.No 75.955. – 3: Large textile put together of 6 pieces. *Aus 6 Teilen zusammengesetztes Textil*, Inv.No 73.347 (© Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter).



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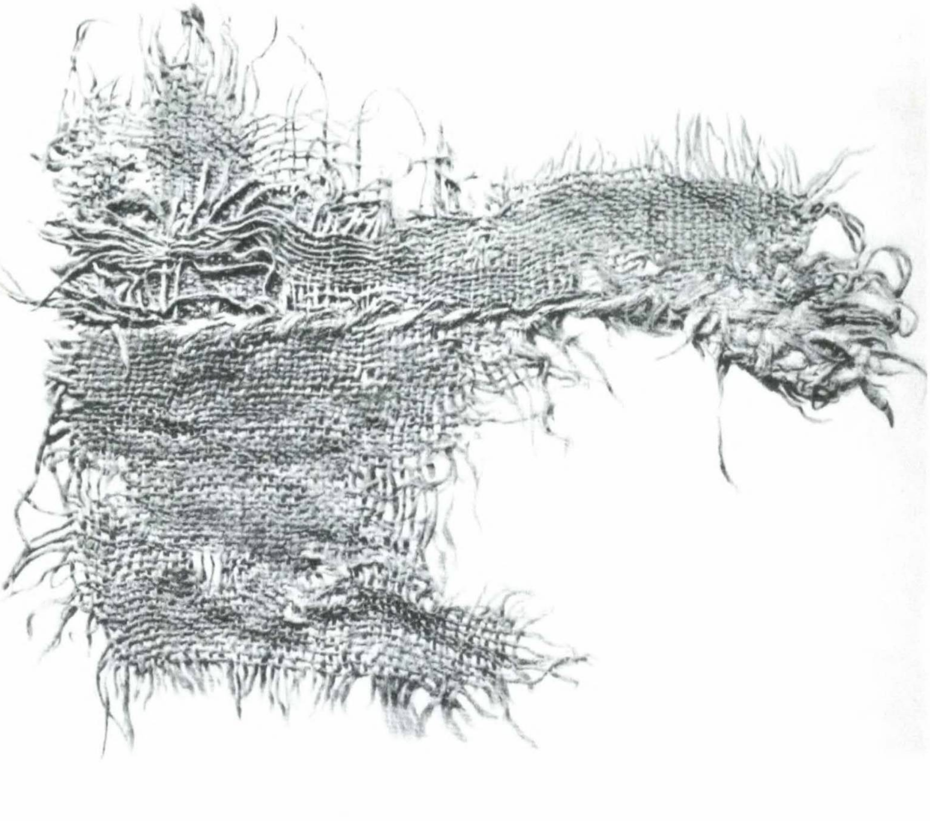


2

Plate 10: Hallstatt salt-mines: 1: patched fabric. *Rechteckige Flickstelle*, Inv.No. 73.346. – 2: mended textile. *Stück mit leinwandbindiger Stopfung*, No. Hundt 44 (1: © Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter. – 2: based on Hundt 1960).

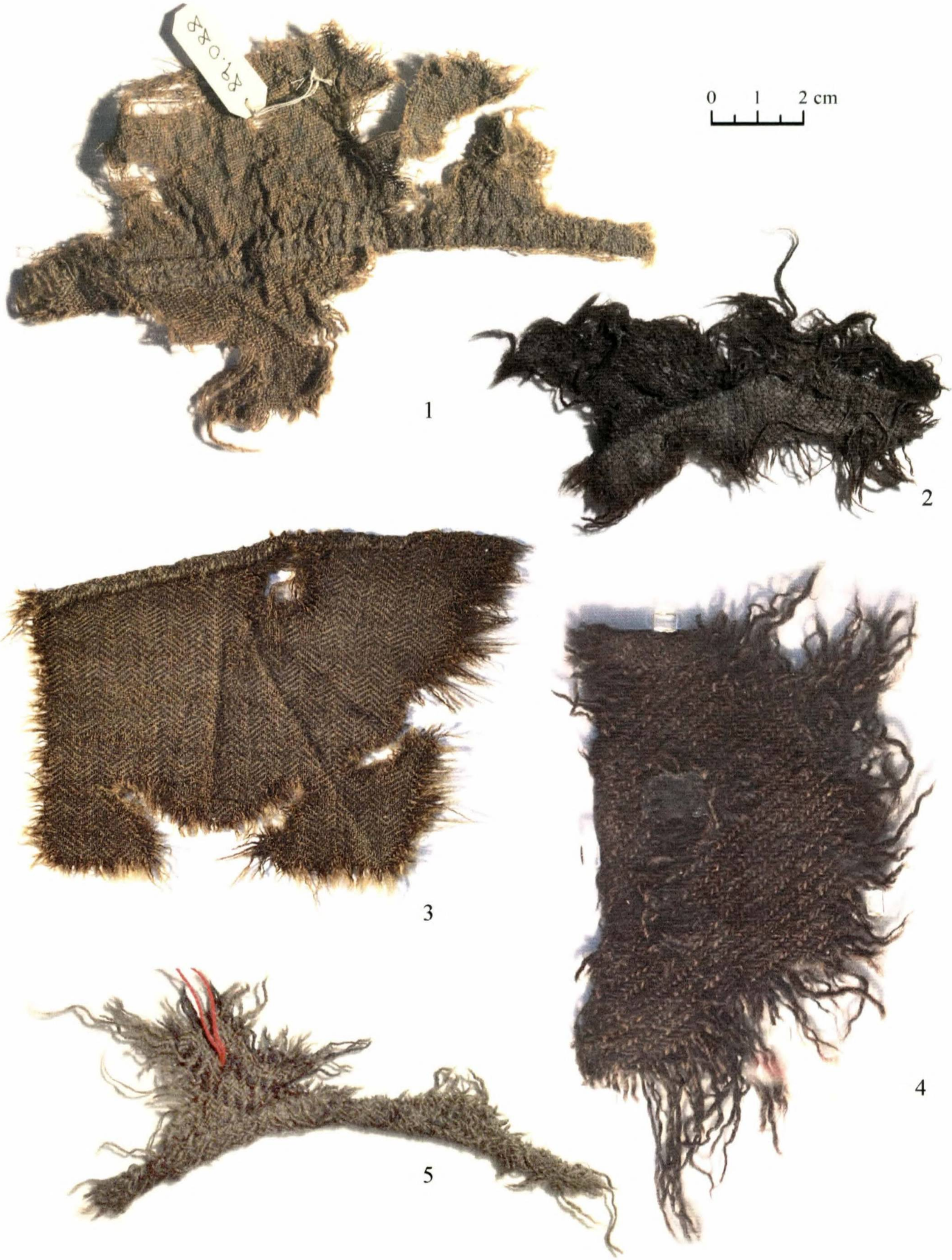
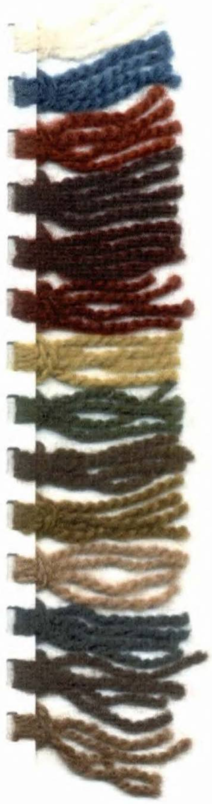
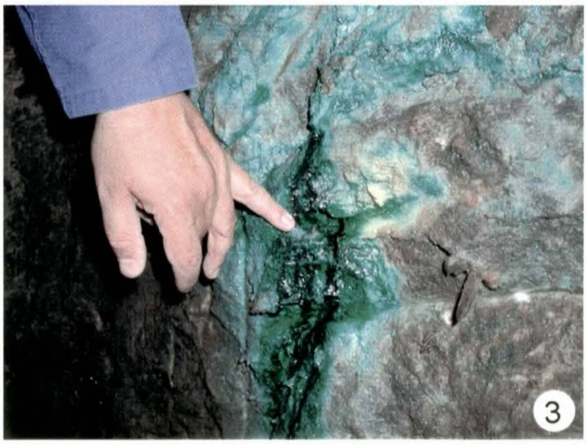


Plate 11: Hallstatt salt-mines: 1: Fabric with fell seam. *Fragment mit Kappnaht*, Inv.No. 89.088. – 2: Rectangular patch. *Rechteckiger Einsatz (durchLagerung verzogen)*, Inv.No. 90.132. – 3: Hem with a corner. *Saum mit Ecke im stumpfen Winkel*, Inv.No. 75.989b. – 4: *Hem meets Hem*. Fragment mit Saum normal auf Saum, Inv.No. 73.340. – 5: Fabric with round hem. *Gerundeter Saum*, Inv. No. 77.569 (© Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter)



1	**undyed wool**
2	indigo
3	madder (alum)
4	madder (alum), top-dyed with indigo
5	madder (alum), post-mordanted with iron salt
6	madder (alum), post-mordanted with copper salt
7	dyer´s broom (alum)
8	dyer´s broom (alum), top-dyed with indigo
9	dyer´s broom (alum), post-mordanted with iron salt
10	dyer´s broom (alum), post-mordanted with copper salt
11	oak bark (direct)
12	oak bark (direct), top-dyed with indigo
13	oak bark (direct), post-mordanted with iron salt
14	oak bark (direct), post-mordanted with copper salt

1



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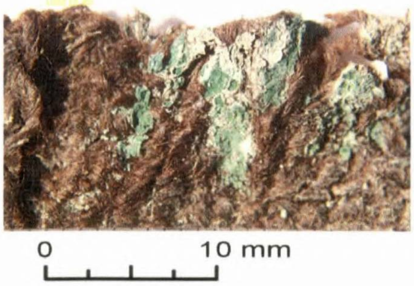

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Plate 12: Dyes and dyeing techniques: 1: white woollen yarn dyed with indigo, madder, dyer's broom, alum, iron and copper salts. – 2: Bronze pick (reconstruction). – 3: Copper salts in the surroundings of a broken-off tip of a bronze pick in the prehistoric salt mine of Hallstatt. – 4: Fragment of fur from the salt-mine, the olive-green colour is probably caused by copper salts originating from bronze objects embedded in the mine. – 5: reddish brown textile contaminated with copper salts, Inv. No. 89835, (1 and 3: © University of Applied Arts Vienna, Dept. Archaeometry. – 2, 4 and 5: © Naturhistorisches Museum Wien, Prähist. Abteilung).

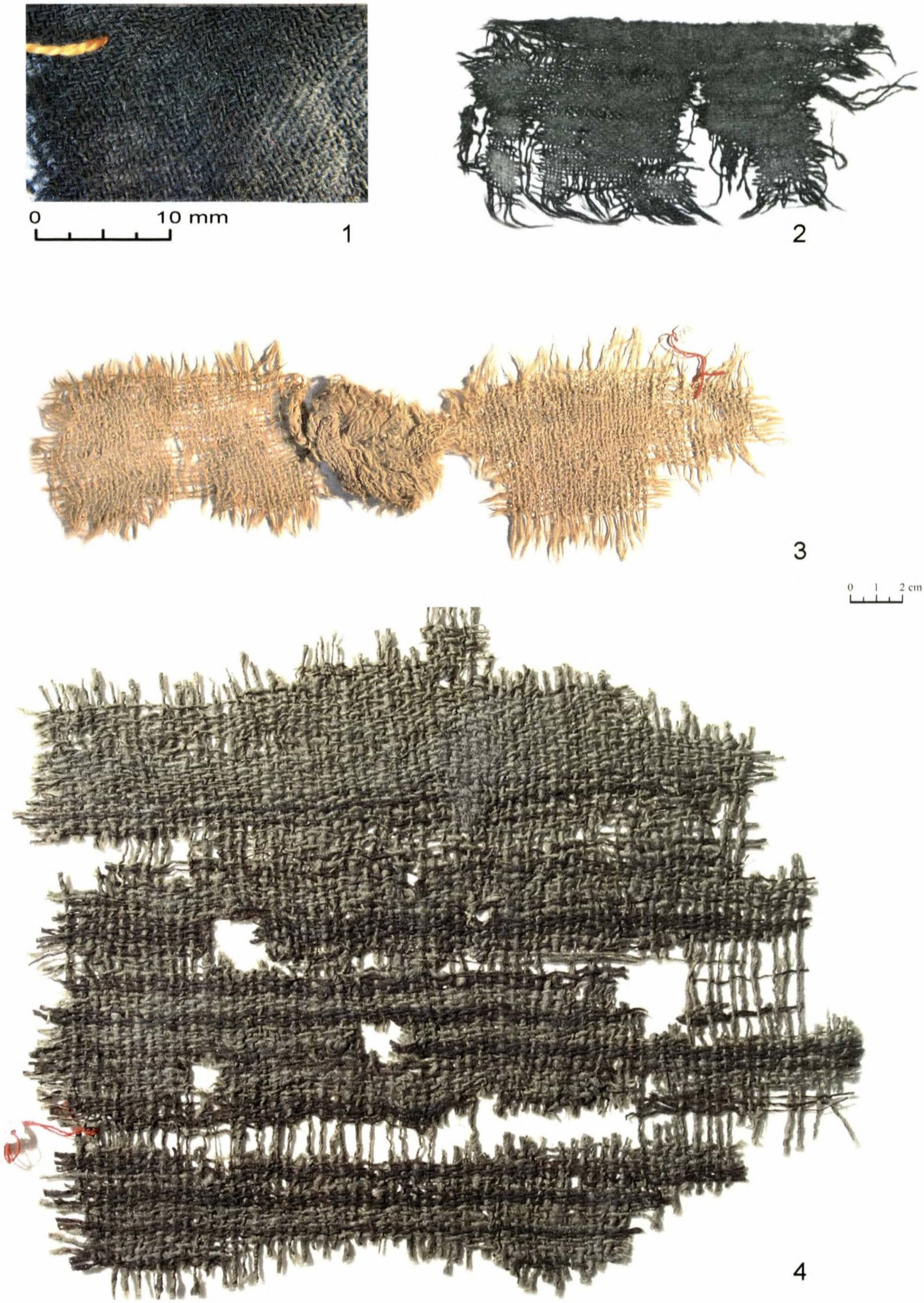


Plate 13: Dyes and dyeing techniques: 1: detail of a blue textile, Inv. No. 89845a. – 2: black textile, Inv. No. 88892. – 3: yellow textile, Inv. No. 77334. – 4: olive-green textile, Inv.No. 75815 (© Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter).

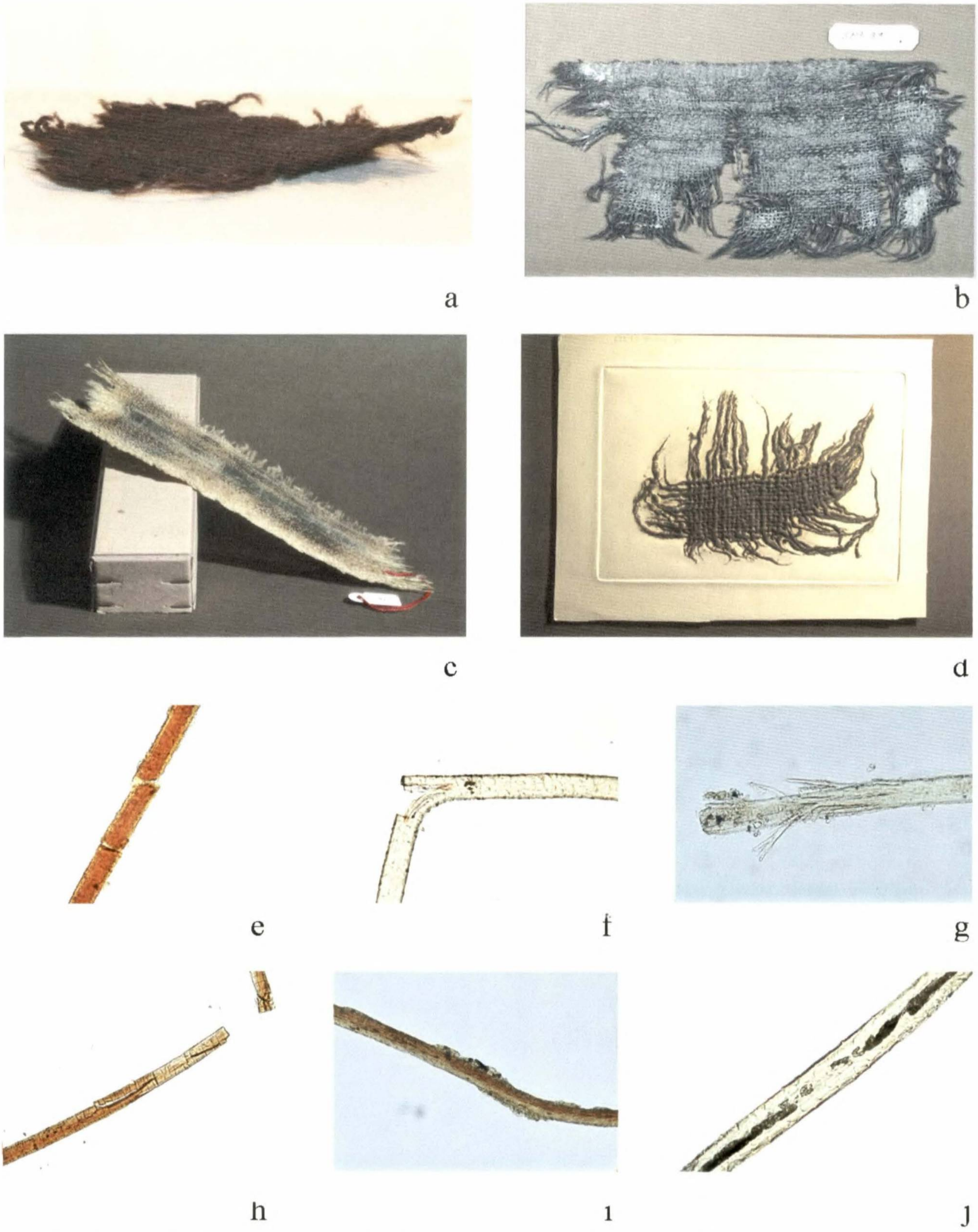


Plate 14: Textilien und Faserproben aus dem Salzbergwerk in Hallstatt. *Textiles and fibresamples from Hallstatt:*

a: Flach gepresstes Fragment mit gewölbter Deformierung. *Fragment pressed flat bent out of shape.*

b: Fragment mit verhärtender lehmiger Verschutzung. *Fragment with encrusted loamy soiling.*

c: Fragment mit Festigungsmaterial behandelt. *Fragment treated with consolidant.*

d: Kolorierter Kartonabdruck eines Fragmentes. *Coloured card print of a fragment.*

e: Wollfaser mit harten Querbrüchen, Faserstärke: 2,5 µm. *Fragment with strong cross breaks, Fibre thickness: 2,5 µm.*

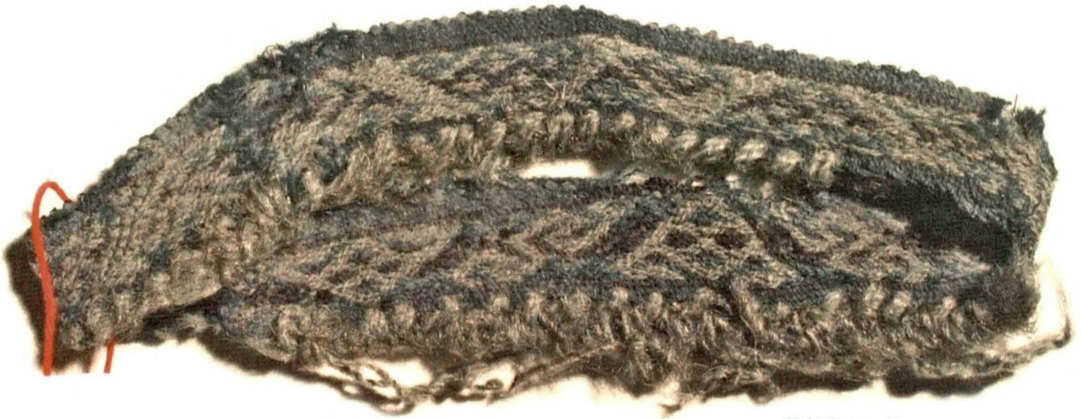
f: Wollfaser mit bogenförmiger Deformierung und beginnendem Quer- und Längsbruch, Faserstärke: 4 µm. *Wool fibre with curved deformation and starting cross and length break, fibre thickness: 4 µm.*

g: Faserende, Spliss und Partikel, Faserstärke: 2,5–3 µm. *Fibre end, breakage and particles, fibre thickness: 2,5-3 µm.*

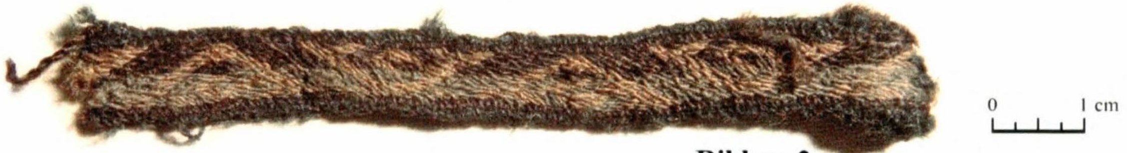
h: Wollfaser mit Längsbrüchen, Faserstärke: 3-3,5 µm. *Wool fibre with longitudinal separation, fibre thickness: 3-3,5 µm.*

i: Wollfaser, dunkle und transparente Partikel, Faser: 2,5 µm. *Wool fibre, dark and transparent particles, fibre: 2,5 µm.*

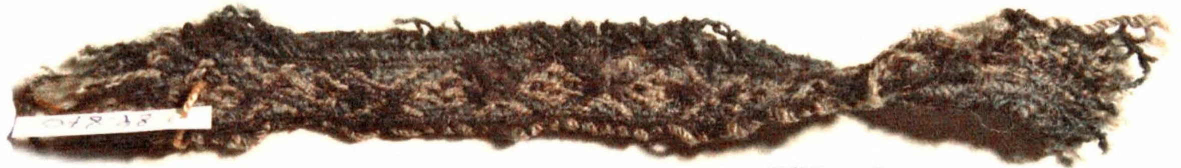
j: Wollfaser in gutem Zustand mit Schuppen und Markkanal, Faserstärke: 4 µm. *Wool fibre in good condition with scales and medulla, fibre thickness: 4 µm* (© Naturhistorisches Museum Wien, Prähist. Abteilung).



Ribbon 1



Ribbon 2



Ribbon 3

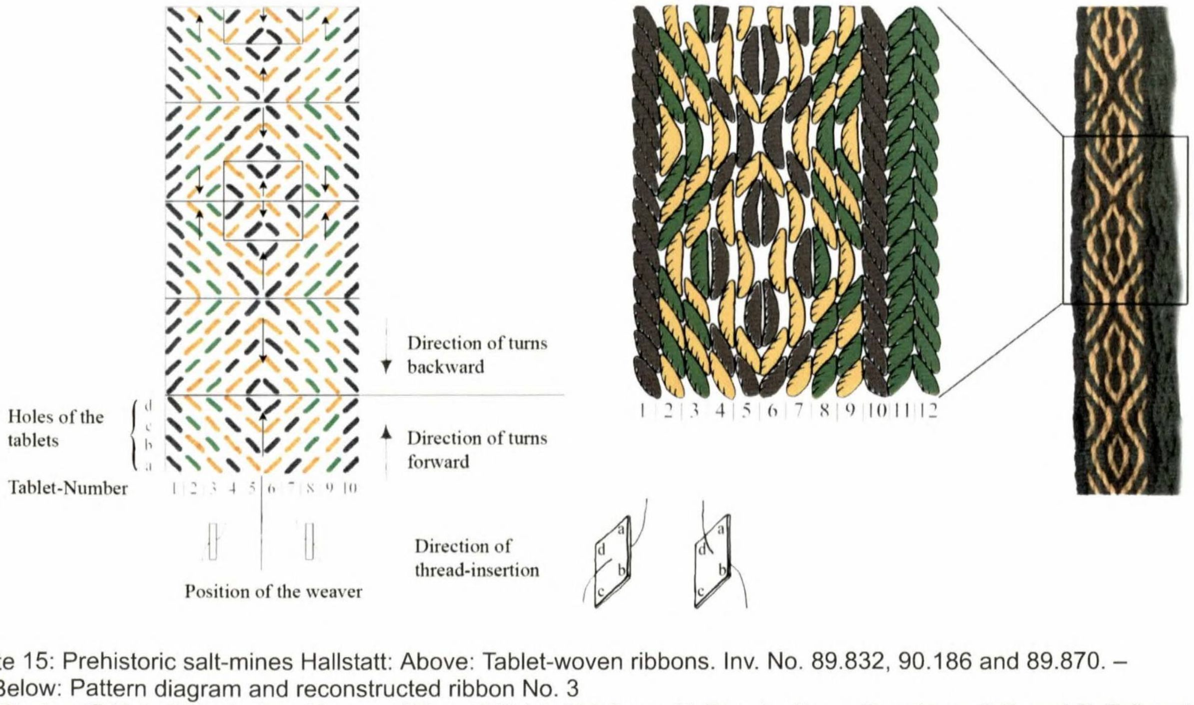
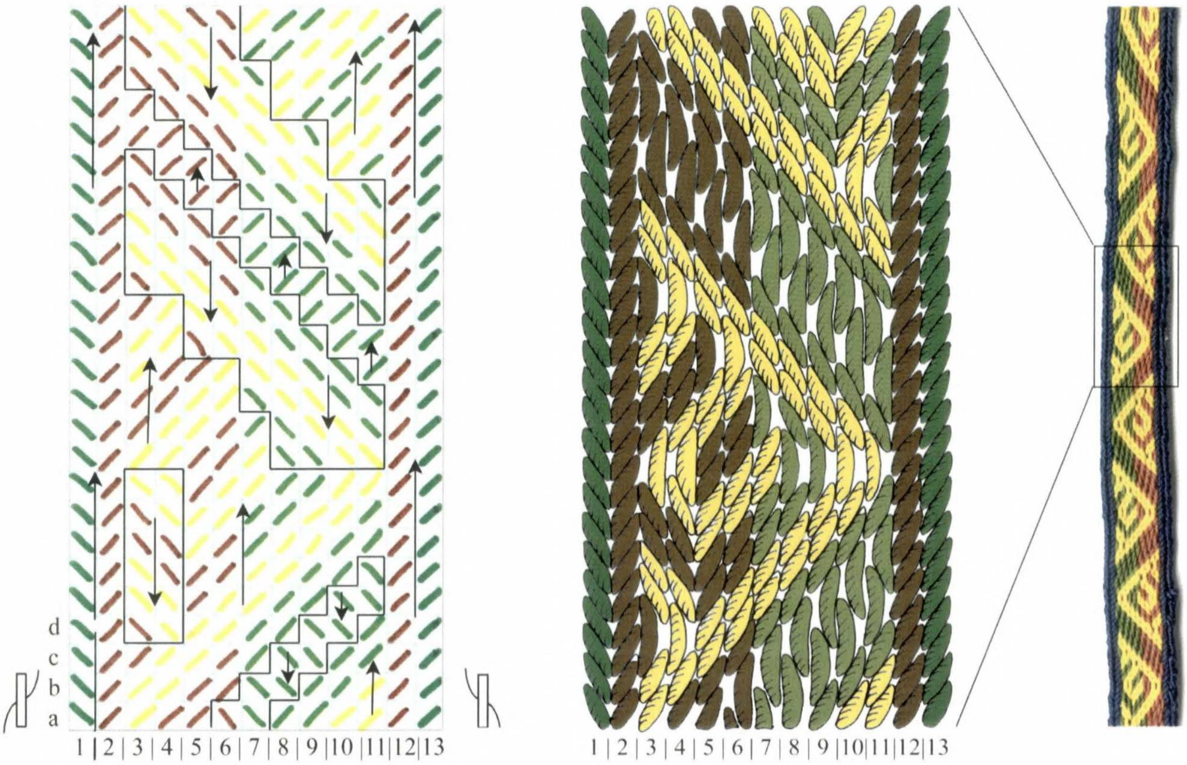
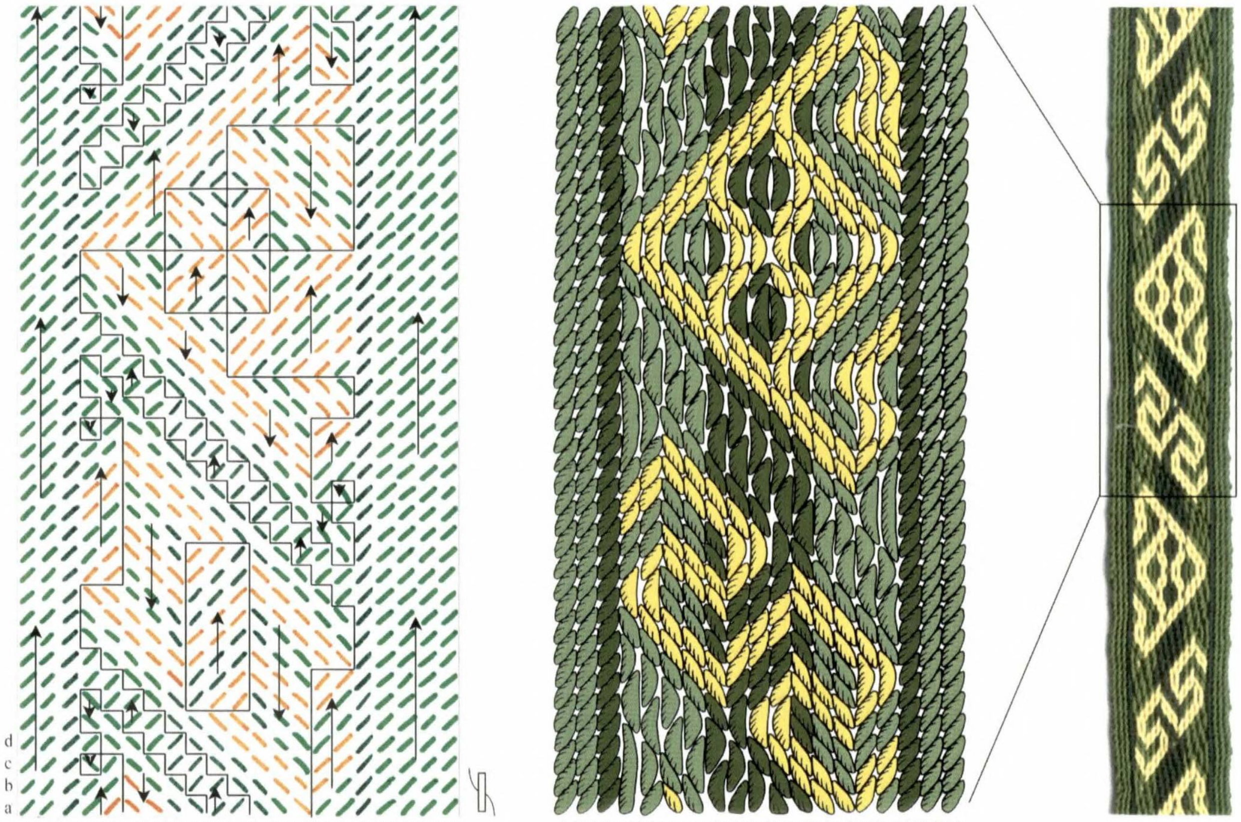

Direction of turns backward
Holes of the tablets
d
c
b
a
Direction of turns forward
Tablet-Number
1 2 3 4 5 6 7 8 9 10
1 2 3 4 5 6 7 8 9 10 11 12
Direction of thread-insertion
Position of the weaver
a
b
c
d
a
b
c
d

Plate 15: Prehistoric salt-mines Hallstatt: Above: Tablet-woven ribbons. Inv. No. 89.832, 90.186 and 89.870. – Below: Pattern diagram and reconstructed ribbon No. 3 (Photos: © Naturhistorisches Museum Wien, Prähist. Abteilung, H. Reschreiter. – Drawings: © K. and P. Grömer).

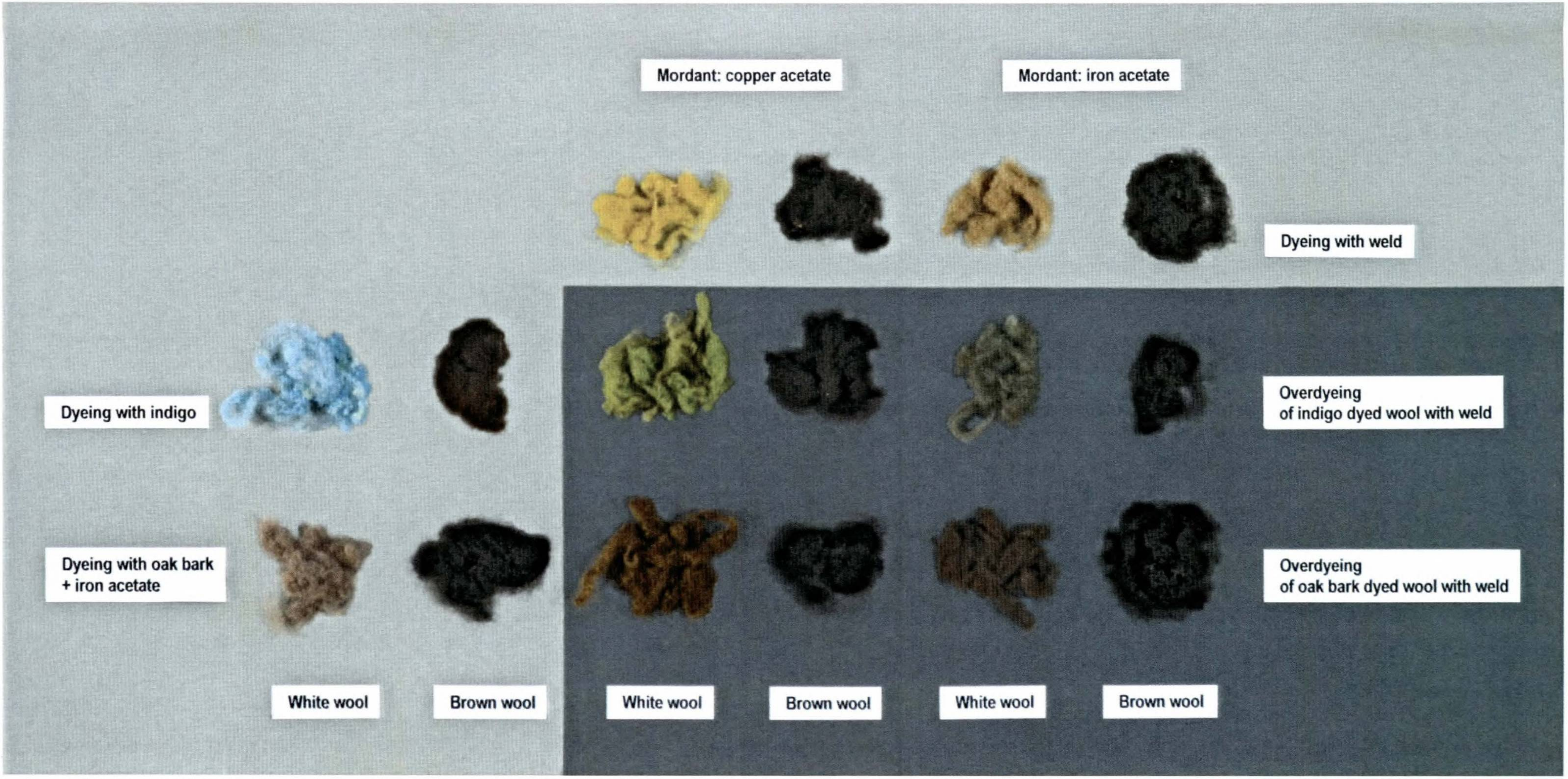

d
c
b
a
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13

Hallstatt Ribbon 2


d
c
b
a
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19

Hallstatt Ribbon 1

Plate 16: Prehistoric salt-mines Hallstatt: Tablet-woven ribbons. Pattern diagrams and reconstructed ribbons from Hallstatt, No. 1 and 2 (© K. and P. Grömer).


Mordant: copper acetate
Mordant: iron acetate
Dyeing with weld
Dyeing with indigo
Overdyeing of indigo dyed wool with weld
Dyeing with oak bark + iron acetate
Overdyeing of oak bark dyed wool with weld
White wool
Brown wool
White wool
Brown wool
White wool
Brown wool

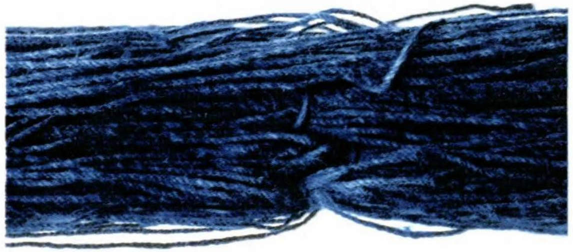
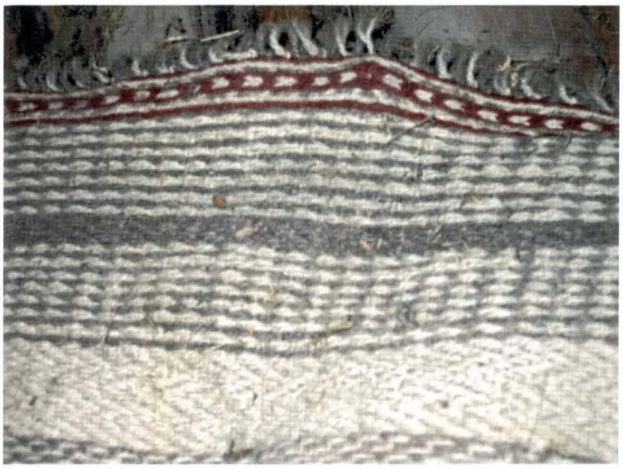


Plate 17: Picture 1: Dyeing results: From left to right, first row: dyeing with weld + copper acetate on white wool and brown wool, dyeing with weld + iron acetate on white and brown wool. Second row: dyeing with indigo on white and brown wool, dyeing with indigo overdyed with weld + copper acetate on white and brown wool, dyeing with indigo overdyed with weld + iron acetate on white and brown wool. Third row: dyeing with oak bark + iron acetate on white and brown wool, dyeing with oakbark/iron acetate overdyed with weld + copper acetate on white and brown wool, dyeing with oakbark/iron acetate overdyed with weld + iron acetate on white and brown wool.
Picture 2: Wool dyed with indigo using a urine vat (© A. Hartl).



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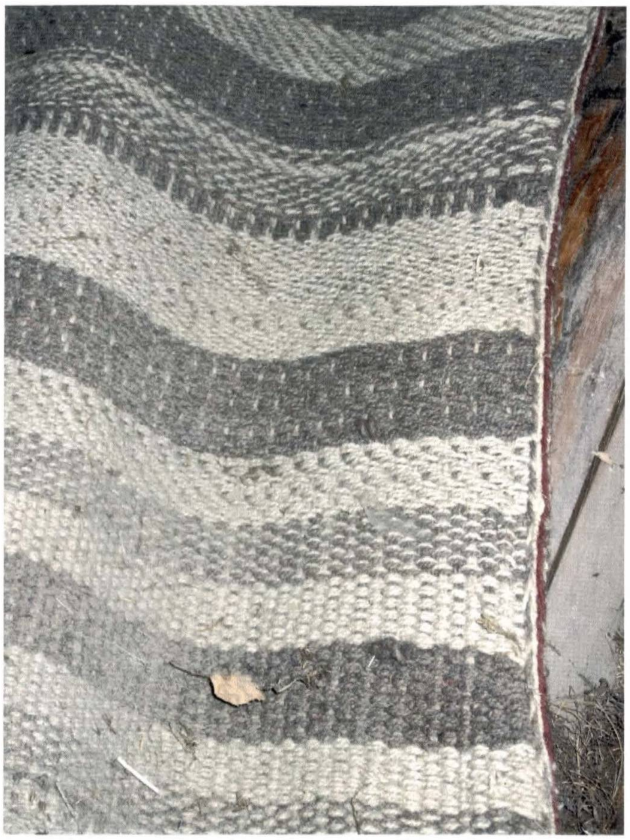

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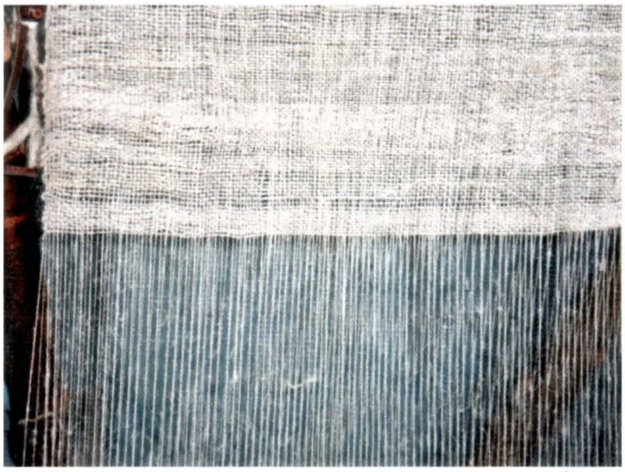

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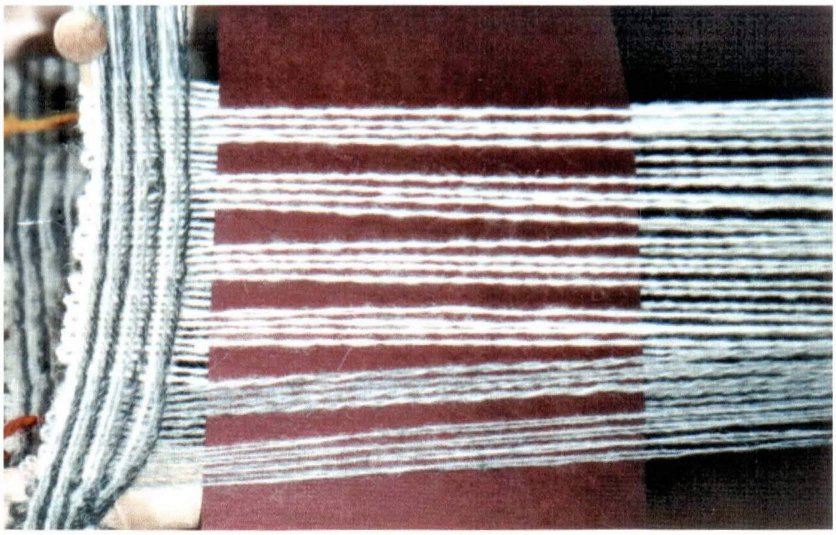
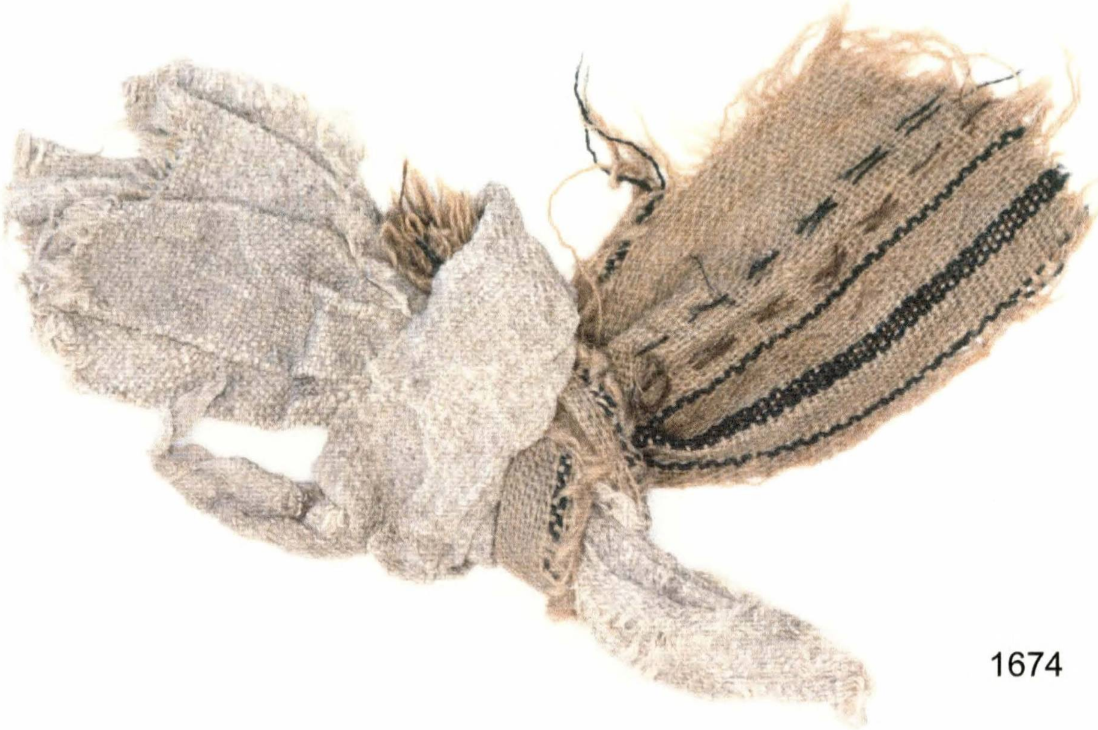


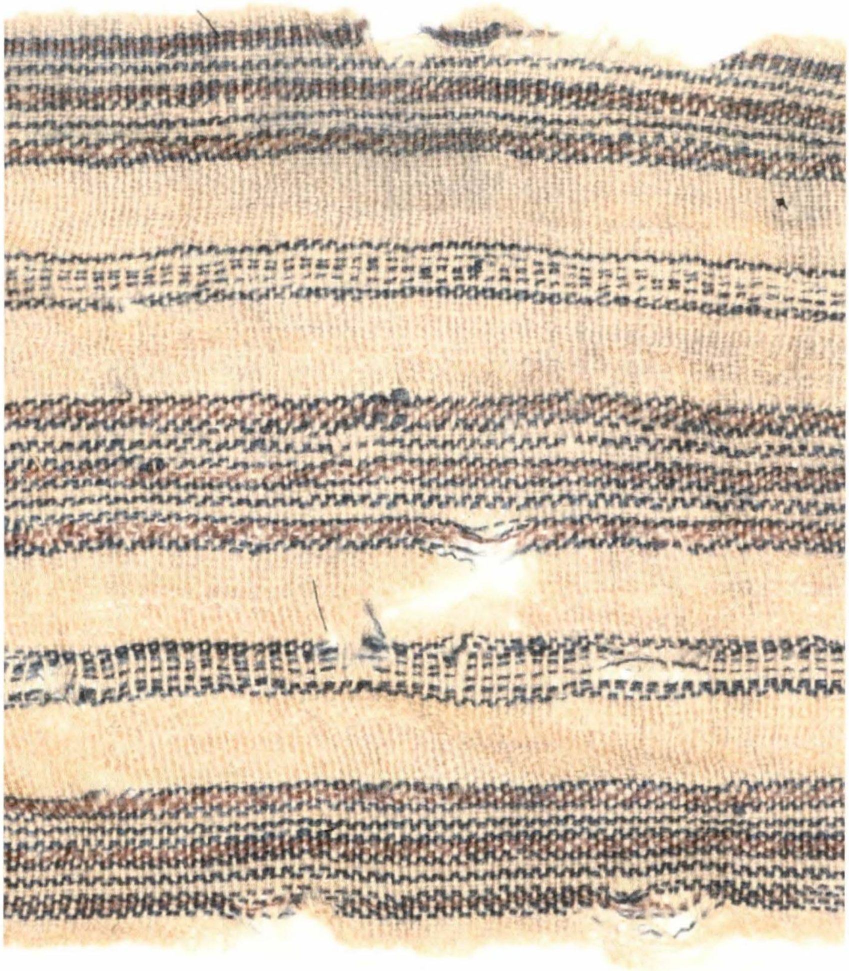
4

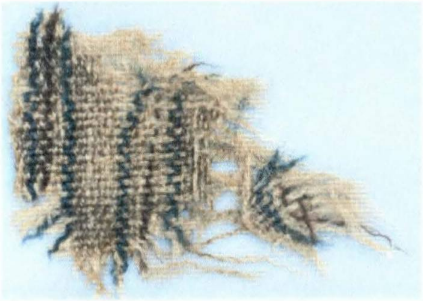
Plate 18: Weaving-Experiments done in Asparn: 1: One of the first weaves done in Asparn, produced on a big warp-weighted loom; twill with a tablet-woven starting border. – 2: The same weave, showing the change of pattern and the tablet-woven border on the right side. – 3: Finely woven tabby fabric, yarn not plied. – 4: On the left side there is the tablet woven starting border; on the right side there are the long threads, intended to build the warp (© I. Schierer).



1674

2190





25

1664

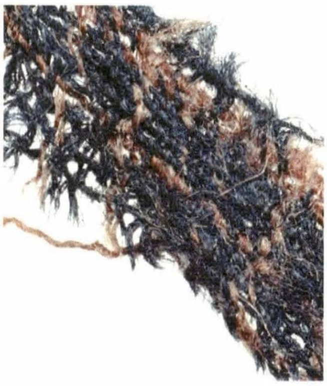
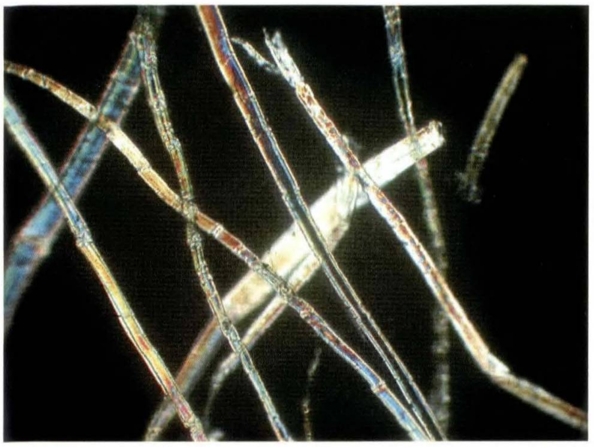


Plate 19: Dürrnberg salt-mines: Examples of coloured textiles. Typical are coloured stripes woven in. 25, 1674 and 2190 are naturally coloured besides the decorative yarns, while 1664 is coloured with woad. The bright red dye was determined as a mixture of Kermes vermilio and madder (© based on Stöllner 2002/2003).



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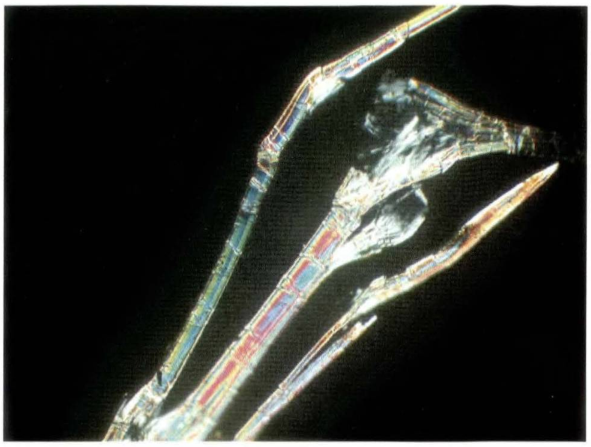

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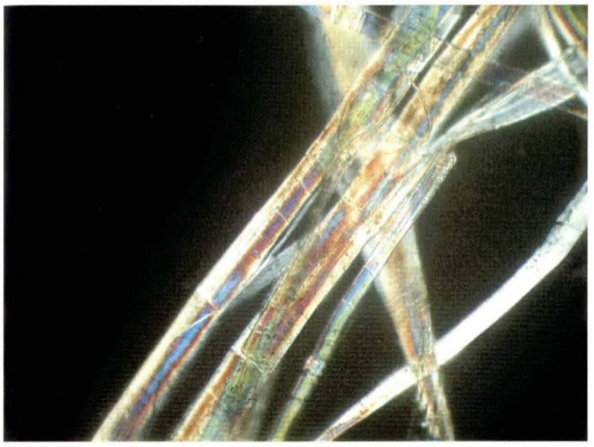

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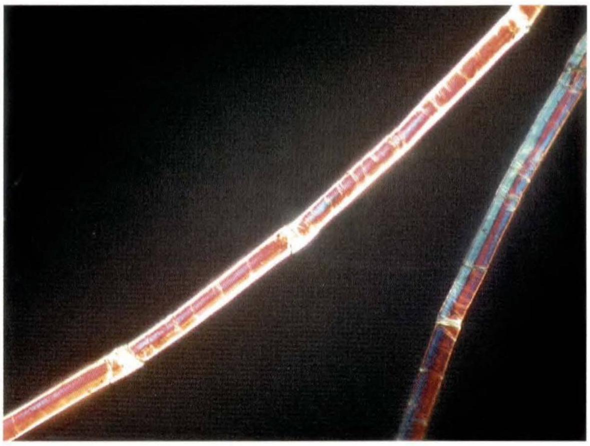

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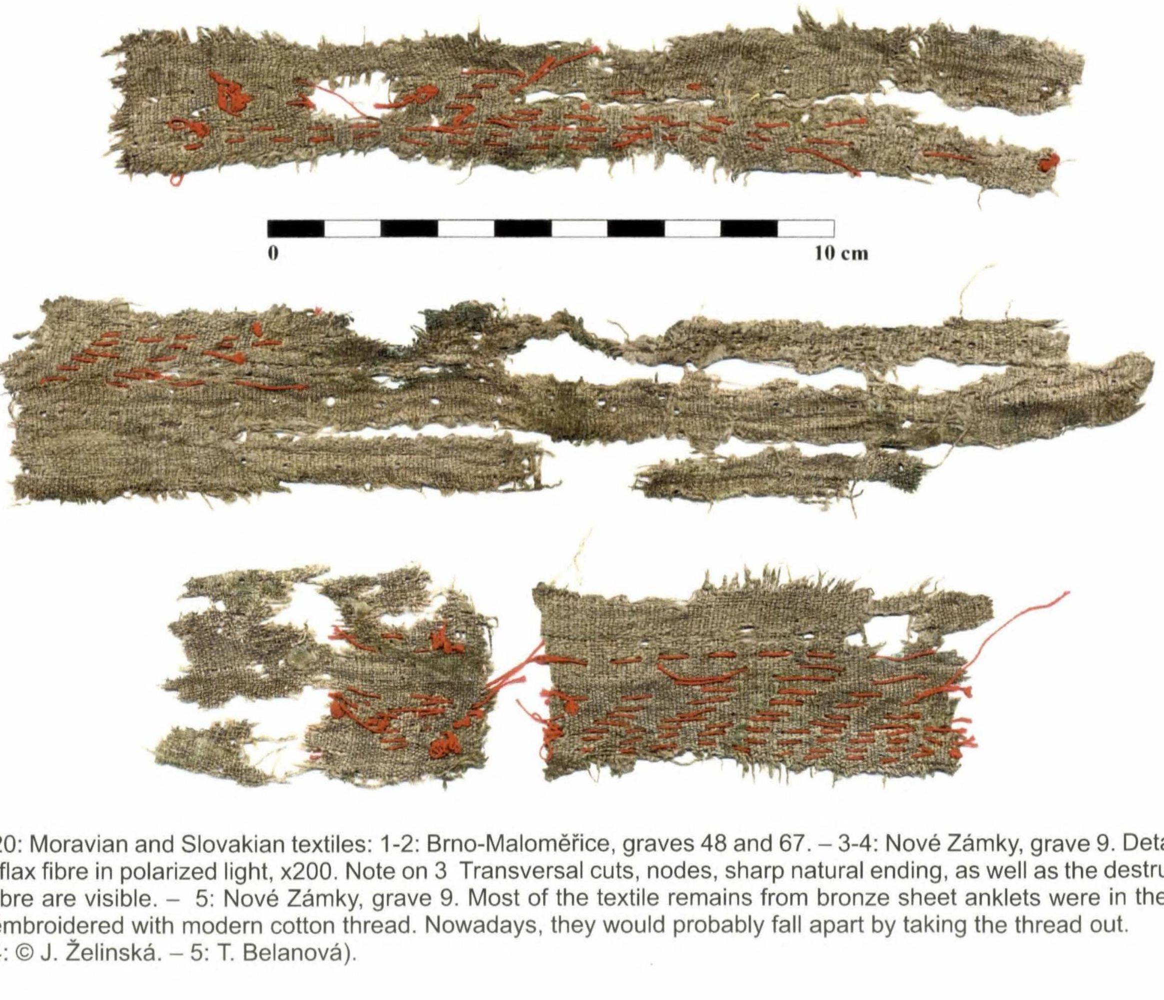

5

Plate 20: Moravian and Slovakian textiles: 1-2: Brno-Maloměřice, graves 48 and 67. – 3-4: Nové Zámky, grave 9. Details of the flax fibre in polarized light, x200. Note on 3 Transversal cuts, nodes, sharp natural ending, as well as the destruction of fibre are visible. – 5: Nové Zámky, grave 9. Most of the textile remains from bronze sheet anklets were in the past re-embroidered with modern cotton thread. Nowadays, they would probably fall apart by taking the thread out. (1-4: © J. Želinská. – 5: T. Belanová).